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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ECONOMIC TREND OF BOTANY[1]

IT can scarcely be successfully denied that the most significant recent advances in American botany have been along economic lines. By many of our younger botanists the dominance of the practical point of view is taken for granted, but to some of our older investigators and teachers the changing attitude has brought something of a shock. And there are a few who are not yet conscious of the great economic tide which is engulfing us. For the sake of this last group it will be well to consider briefly a few historical facts. As yet within the memory of the older living botanists, American botany was scarcely more than the taxonomy of the vascular plants. In the eighties we began importing the laboratory method from Europe, particularly from Germany. It was the psychological moment, and naturalization took place with surprising swiftness. At first, the new movement found expression mainly in the direction of morphology and anatomy. By the early nineties, however, a pronounced physiological trend found large place, and in the late nineties ecologists began taking the laboratory method to the field.

No attempt will be made to picture here the rise of economic botany. It may be pointed out, merely, that in our older programs it had very little place. A somewhat notable exception to this is afforded by medical botany, which has long been paid attention to by botanists. Indeed,

[1] Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, Philadelphia, December, 1914.

botany almost began with an attempt to find the cures for human ills. So it was natural enough that posts of botany in the olden time should be assigned so generally to physicians, and that so many physicians should cultivate botanical science. Even to-day, in many European universities botanists who know nothing of such things are often obliged to give lectures along these lines to medical students.

It is only a few years ago that our botanical programs were made up almost entirely of the reports of investigations in what we are accustomed to call pure science, as though applied science were impure. But see what we have to-day! It is a conservative estimate to say that three fourths of our botanical investigation is now along economic lines, as compared with essentially none at all, when the oldest among us were beginning botanical research.

If one were to count the titles in the present program of the Botanical Society of America, he might be inclined to dispute this statement, but it must be remembered that the majority of the economic papers are now given in the various technical societies. Immediately previous to the formation of the American Phytopathological Society, approximately half of the titles offered in the combined programs of Section G and the Botanical Society were phytopathological. If we take account of the work done by the various divisions of the United States Department of Agriculture and by the many state agricultural colleges and experiment stations, by workers in bacteriology and plant breeding, and by investigators in the forest service, it will be realized that more rather than less than 75 per cent. of our botanical investigation is economic.

Whatever may have been the scientific deficiency of much of this work in the past and of part of it to-day, it must be admitted that there is coming from these sources an increasing body of work of the highest value scientifically. This is well indicated by the *Journal of Agricultural Research,* which from the first number has taken rank with our best botanical journals.

It is scarcely to be supposed that economic botany is a passing fad, and that pure botany, as we call it, will once again come into a place of dominance. The shifting emphasis in botany is but a part of a great movement as broad as humanity itself. The three sections that have been most recently organized in the American Association for the Advancement of Science are practical rather than theoretical, and the last of these, agriculture, is one which is looming up everywhere as a competitor of botany. Chemistry and physics also are being swept with the same economic title.

No better index is to be seen of the trend of the time than in the curricula of schools and colleges. Once the central feature of our educational system was the disciplinary study of the classics. Latin and Greek, subjects which survived the barbarism of the middle ages and the changing viewpoints of subsequent centuries, have given way before our modern demand for culture that is practical; and it is doubtful if they can ever again take a leading place in educational systems. In many of our secondary schools botany has given way, and perhaps permanently, to agriculture, and in many others agriculture is introduced along with botany, or the demand is made that botany be made practical. Naturally the last institutions to feel the press of the new movement will be the private or endowed institutions, such as the University of Chicago, from which your speaker comes. But even we are feeling it. An increasing number of our stu-

dents are demanding more practical courses or are going elsewhere through failure to find them with us, and what is more, an increasing number of schools are demanding teachers with more practical training than we have been supplying. Last summer one of our graduates, well trained in theoretical botany, was offered a position if she could teach agriculture. Fortunately we had imported a professor of agriculture for the summer, and the young lady took a hurried course, and secured the position. An increasing number of opportunities are offered to qualified graduates prepared to take up work in agricultural colleges and experiment stations, and a relatively decreasing number of places are available in theoretical botany.

If the situation above depicted is a general movement rather than a passing whim, it is evident that in many of our institutions botany to remain a living force must change its methods. It may, as did Latin and Greek, stand inflexibly for past ideals and decline, or it may adjust itself to present-day problems and live with increasing vitality. We must not be deceived by the fact that more of us than ever before are engaged in the pursuit of theoretical botany. It is not a question of absolute, but of relative, numbers, and by that test theoretical botany is losing. For one, I mourn the passing of Greek and Latin. To me those languages have been immensely practical and I do not at all regret the seven years I employed in their study. Yet how much better off we all would be had the classics, as we took them, been related to our modern life! And they might have been so related, for there are many points of contact, but your teachers and mine held rigidly for classics for the classics' sake and for disciplinary values; and it is for this that they have fallen.

At Chicago, we still adhere to the ancient notion that the A.B. degree should stand for training in the classics, and the result, of course, is a great decline in A.B. graduates. Some convocations pass without a single student taking that degree. One day I asked one of our professors of Latin if the slump in Latin and Greek were general and permanent or merely local and temporary, and he replied with sadness: "I feel that it is world-wide and lasting; even Oxford feels it. Almost the only ray of hope for us is that the botanists still require the diagnoses of species to be in Latin."

It would be a world tragedy if theoretical botany should die, or even if it were to be less influential than it is at present. It is vastly more important than are Greek and Latin, and yet their decline is to be contemplated with profound regret. But botany is the foundation of agriculture, and agriculture is the most fundamental employment of the human race.

To be sure, we can farm without being botanists, but we can not farm so well. Through the ages agricultural man has stumbled on many important facts and principles that the botanist has later on explained, thus making more scientific farming possible. Witness the enrichment of land by growing leguminous crops—a fact mentioned by Pliny, and explained by modern botany, and as a result utilized with vastly increased success by the present-day agriculturist. Witness, too, the history of our knowledge of the wheat rust, or the recently discovered hereditary symbiosis of bacteria and seed plants—phenomena seen by agriculturists as in a glass, but very, very darkly until the theoretical botanists explained them.

In spite of these instances and a hundred more, the practical man is coming increasingly to look with scorn upon the

theoretical botanists. What matters it, say we? Alas, it matters much, unless we happen individually to be endowed. For botanical positions, like other things in life, are controlled by the law of supply and demand. In more than one institution that I know the tenure of position of the botanist depends upon his success in attracting students. The student, needing bread and butter, will not be attracted to lines in which he can not earn it, and, as Mr. Dooley says, "There ye are." In several state universities the clash has already come, and in every case of which I am cognizant, the more practical botany of the agricultural department has won as against the more theoretical botany of the academic department. Even in our private institutions we commonly have practical trustees who sooner or later may see the trend of the time and act accordingly.

Notwithstanding the sorry picture just painted, I suspect that all of us believe at heart that the most fundamental aim of botany is the improvement of the human race. All of us desire as our supremest wish, that we may do something in our brief life to make man's lot better than before we came. Therefore, it remains only to make concrete our inmost ideals, in order to save the day for botany, as it was not saved for Greek and Latin.

A good many years ago I published a paper on the vegetation of the sand dunes of Lake Michigan, depicting the principles of plant succession, as there so strikingly illustrated. Shortly after, with an expression on my face betokening, "There now, isn't that something like?" I gave a copy to a man of the world, who said merely "Well, what of it?" Aghast, I said nothing and only now, fifteen years afterwards, is the answer forthcoming. It is as follows:

Two years ago I was surprised to receive a message from the United States Department of Justice, asking for my services as an ecological expert in some government cases in Arkansas. With many misgivings, and with the feeling that ecology, as I represent it, was now specifically on trial, I took up the work assigned me. To my unalloyed gratification I discovered that matters which perplexed the Department of Justice were simple enough when examined by an ecologist rather than by an attorney. In 1847 the original survey was made by the United States of the bottom lands along the Mississippi River in eastern Arkansas, and the country was opened for settlement. A great deal of the area was surveyed as permanent lake, and is so shown even on the most recent detailed maps. At the present time these so-called lakes are occupied by heavy timber of great value. Furthermore, this "lake" land is very fertile, and much in demand for raising corn and cotton. However, as it is termed lake in the original survey, it can not be homesteaded and farmed. A few years ago certain lumber interests, having used up the high-grade timber on the surveyed lands, looked with envy on the splendid timber growing in these so-called lakes. Consequently they conceived the idea of purchasing riparian rights from the owners of the adjoining surveyed land, and they proceeded to cut the timber. Shortly afterwards the United States government instituted suit against these lumber interests, its contention being that the original survey was fraudulent, that lakes did not exist in 1847, and that riparian rights therefore did not inhere. In the meantime, pending settlement, provisional entries were made by "squatters." While test suits were made on only a few of these so-called lakes, there exist many tracts of similar nature, involving in the aggregate

many thousands of acres and property values up into millions of dollars.

As an ecologist it was my duty to determine from present indications the nature of these so-called lakes in 1847. The work was ridiculously easy, since it was found that these "Lake beds" were covered with upland timber of great age. The attorneys for the lumber interests endeavored somewhat half-heartedly to show the inaccuracy of the method of determining the age of the trees by a count of the annual rings, but in the face of the hundreds of years of age shown by many of the ring counts, this contention had short shrift.

Somewhat greater efforts were put forth in support of their claim that trees can grow in lakes, much being made of the well-known fact that the bald cypress, *Taxodium distichum,* occurs in well-defined bodies of water. It was here that the ecological argument had its greatest force. Having visited the country of the lower Mississippi on two previous occasions and having made four trips to the territory in question during the course of my work for the government, I was in a position to know the main facts in the ecological succession on the Mississippi bottoms.

Employing the happy terminology of W. S. Cooper, there are two types of hydrarch succession in the area in question, that from the river and that from the lakes which generally are back of the levee or in old cut-offs due to a shifted course of the river. On the river front, as the alluvium is built up, there is frequently seen a sandbar vegetation of ephemeral annuals associated with low summer levels of the river. Back of this there appears the first ligneous vegetation, dominated usually by willows, such as *Salix longifolia* and *S. nigra.* Further back there appear more or less definite stages of vegetation, each stage associated with a water table of a given depth, culminating in the great river-bottom forests of *Quercus texana, Q. lyrata, Acer rubrum, Liquidambar, Celtis,* various hickories, *Populus deltoides, Ulmus, Platanus, Fraxinus americana,* and the like. It is probable that this forest type is not the permanent climax of the region, but rather a very long-enduring temporary climax.

In the lakes, whether formed by the elevation of natural or artificial levees or through the shifting of the river channel, the course of vegetational development is somewhat different. At first there is a pond vegetation with *Nelumbo* and other pond aquatics. Following this one finds at times a flag grass prairie or again a willow belt, much like that of the river front. The most striking feature of these lake successions, however, is the stage dominated by the tupelo, bald cypress and water locust, which usually follows the willow or prairie stage. As shown by the great age of the trees (tupelos of 200 years, and cypress of 700 years having been observed), this stage may last for a long time.

It is particularly important to note that many tupelo and cypress trees were seen to have been killed by submergence during periods of high water, thus showing that these trees are properly trees of the land rather than of the water. If they occur in lakes, as they do, this fact would seem to indicate that the lakes are but temporary, or at least that there were only short periods of particularly high water during their early life. After these trees there comes a forest of red maple, sweet gum, pumpkin ash, planer, pecan, etc., and then again after a lapse of many more years there comes the characteristic forest of the so-called lakes, the temporary climax forest above noted, with its gigantic oaks, hackberries and other trees of the dry ground; therefore, when one cuts an over-

cup or Texan oak and finds it to have an age of 300 years, it is clear from these facts of ecological succession that it has been much more than 300 years since there was a lake, where the trees now are.

Through a study of trees that germinated on these lands in and about 1847 I was able to determine that at that time the conditions were essentially as at present, since in the so-called lake beds the same species of trees are developing now as in 1847. I testified that in the lands in suit the evidence of ecological succession shows beyond all question that even a thousand years ago these so-called lakes must have been land, and it is my firm belief that there have been no lakes in these sites for at least two thousand years.

The physiographic evidence corroborated the ecological evidence in striking fashion. It is a well-known fact that deposit is more rapid on the immediate banks of the Mississippi than farther back, much coarse material being deposited near the shore, whereas further back the material is finer and finer and constantly less in amount. It is this fact that accounts for the formation of the natural levees; thus in these so-called lakes which mostly lie some miles back of the river front, the alluvial accumulation is slight. It is mostly to the much slower accumulation of vegetable material that they owe their gradual elevation above the water table. Excavations near the river and in the so-called lakes brought out this difference most strikingly.

Furthermore, the spur roots which are sent out at the ground line are still uncovered by accumulated alluvium, even on the oldest trees. Had lakes existed in 1847 and been subsequently filled by detritus, it is clear that the spur roots of old trees would be deeply buried. In the so-called lake beds there are many logs of trees that fell in the earthquake of 100 years ago, and even these logs are still unburied, thus showing an absence of appreciable alluvial accumulation for at least a century.

Two questions may have occurred to you that are more of human than of ecological interest. What was the object of a fraudulent survey of such colossal magnitude, and how were the suits decided? As to the motive of the surveyors, it may be noted merely that in 1847 our government surveyors got a certain sum per mile for ordinary surveying, and considerably more for surveying lake shores because of the greater difficulties involved; it was an object to return lakes, even if the meander lines had to be traced while in camp. As to the decision of the suits, the district judge at Little Rock, in the first test suit, made a sweeping decision in favor of the government as against the lumber interests, though an appeal has been taken to the higher courts. It may Be interesting to note that the judge based his decision largely on the ecological facts, in the face of testimony given by some of the oldest inhabitants that they had actually seen the lakes in question! However, other equally old and perhaps more respectable inhabitants testified that conditions in 1847 were essentially as they are to-day. It was brought out in court that it is safer to believe a tree than a man! Thus a line of investigation which we had supposed to be theoretical only has turned out to have large practical significance.

No claim is made, of course, that this is the first demonstration of the utility of ecology. A field of research of almost limitless possibilities is indicated by Shantz's splendid paper on the natural vegetation as crop indicators in the Plains. Just as untold sums of money have been wasted in the search for gold where the geological formation is such that the pres-

ence of gold is impossible, so countless amounts of time and money have been squandered in agricultural experiment on land whose natural vegetation, if studied, would have directed other uses. One of the best applications of ecology is afforded by the work of Coville, on the culture of the blueberry, of which we are to learn something more to-day. The utilization of acid lands by the growth of crops that thrive in the presence of certain organic acids is a large conception and will doubtless prove to be one of the great utilitarian discoveries of our day.

I will not trespass on your time by indicating further practical applications of my chosen field, ecology. Others will suggest themselves, as will similar applications in various lines of botany, particularly in physiology. If we are to keep botany alive and abreast of the time, we who are in academic botanical departments must give more attention than formerly to the economic aspects of our subject. We must offer more courses in the practical phases of botany. In our research we must not avoid practical problems, but look for them, and we must emphasize the practical possibilities of our theoretical problems. Our sister science, zoology, which perhaps is in a more serious plight than we, gives evidence at this meeting of an attempt to meet the situation by choosing for its symposium the significant topic, "The Value of Zoology to Humanity." Above all we must treat the economic relations of our subject, not as an annex, a thing apart, a "sop to Cerberus," but as the vital and essential thing, the very kernel of it all. By pursuing such a course we shall keep in close relationship with our practical modern life, and we shall justify ourselves to our fellows. We shall then have ample opportunity to continue our researches along theoretical lines. And one may never know how soon a purely academic study may come to be a factor of the first importance in the betterment of the human race.

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CONSERVE THE COLLECTOR

IT is with considerable apprehension that I have observed an unmistakable decrease in the number of collectors during the past six or eight years. Matters of precision and accuracy in the field of ornithology are, I have no doubt, suffering as a consequence of this forsaking of the "shotgun method." Our faunistic literature to be of the highest scientific character must be based on the surest means of establishing the identification of species. The "skin record" is essential, and the availability of this is dependent upon the existence and activity of the collector.

The type of field observer who depends solely on long-range identification is becoming more and more prevalent. But the opera-glass student, even if experienced, can not be depended upon to take the place of the collector. Accuracy in identification of species and especially subspecies rests for final appeal upon the actual capture and comparison of specimens. Ornithology as a science is threatened, and it should not be allowed to lapse wholly into the status of a recreation or a hobby, to be indulged in only in a superficial way by amateurs or dilettantes.

It is to be doubted whether authoritative and expert systematic and field ornithologists can be developed through any other process than by personal collecting of adequate numbers of specimens in the field. The processes of hunting, and personal preparation of bird skins, bring a knowledge of the characters of birds, both in life and as pertaining to their structure and plumage, which can be secured in no other way.

The present tendency toward extermination of the collector bears obvious close relationship to the increasing number of extreme sentimentalists. The latter, beginning in a

good cause, now continue to urge stringency in state and federal laws beyond all reason. Those in authority "high up" ought to know better than to contribute to this stringency; but they, yielding to the pressure of the militant sentimentalists, are allowing laws and regulations to go through without giving apparently any thought to their duty toward the field naturalist, whose function is essential to the conduct of important phases of ornithological study.

Permits should be issued by both state and federal governments freely to applicants upon avowed sincerity of purpose. There should be no hesitation unless there be suspicion as to the honesty of the applicant. Limitations may be properly imposed, as, for instance, by excepting rare or disappearing species like the ivory-billed woodpecker or the Carolina parakeet. This is just as feasible as it is to forbid the sportsman to shoot rare or disappearing game species. Furthermore, the collector, by reason of his more expert knowledge, is far better able to discriminate between closely allied species, and, because of his appreciation of the facts upon which the principles of conservation are based, is more likely to abstain from killing the wholly protected species. As a rule, the birds which particularly interest the collector consist of small species, of wide distribution and large numbers. And the daily "bag-limit" of the collector, self-imposed because of the subsequent labor entailed, is small, seldom exceeding 20 birds all told, and, in my own experience, averaging 12.

Collecting, at best, will be indulged in by but comparatively few people, for it involves much more effort than hunting; the successful collector must possess a considerable equipment in the way of industry and artistic skill if he expects to reach recognized standing in the fraternity of collecting ornithologists; and at the outset he must possess the naturalist's gift or "bent" which is itself not common.

It can be rightly urged in this connection that the justification for collecting non-game birds is just as well grounded as for shooting or otherwise destroying *game* animals. Practically all small birds can better stand an annual toll than most game birds. Citing a single species of non-game bird, the Audubon warbler, I believe that its numbers within the state of California at the beginning of the winter season exceed the combined numbers of all the species of game birds within the state at the beginning of the open season. Yet for the pursuit of game birds over one hundred and thirty thousand hunting licenses were issued last year here in California alone. In the same state, only one hundred permits for scientific collecting were allowed, or only one permit to collect non-game birds to 1,300 licenses to hunt game birds! Most of these permits were limited to two specimens of a kind, and in many cases they were given out grudgingly or under protest, as if the collector were seeking something beyond his rights to ask for, or even as if a question of morality were involved! This again is an attitude (on the part of *sportsmen,* which our State Game Commissioners all are!) hardly consistent, but evidently resulting from the wide-spread influence of the sentimentalist.

As compared with the value of the game bird shot, does not the bird killed for a specimen come much more nearly justifying its end? The game bird practically ends its career of usefulness when it falls before the gun. It has incited recreation and a certain amount of the esthetic in the way of admiration. Perhaps the latter obtains for a few minutes or hours after the death of the bird. But it soon goes to pot and that is the end of it.

With the bird hunted for a specimen, the collector is searching discriminatingly among many species and often among a great many individuals. He is observing many things beyond the mere object of the shot. In addition, full recreative value is being obtained as in the case of game (and this is generally urged now-a-days as *the* value of game—in its service, not as food, but as an object of pursuit and contemplation before killing). The value of a bird shot for a specimen does not end with its death, although it has served the other functions already. The collector prepares the bird with painstaking care, at

the same time acquiring added information, and installs it under safe conditions as an object of study and appreciation for all time. Instead of being merely eaten, it becomes a joy forever.

To my mind, there is no more practical reason for shooting a snipe for sport than for shooting a Savannah sparrow for a specimen.

My thesis is, not that hunting game for sport is unjustifiable, but that hunting both non-game and game birds and mammals for specimens is at least equally justifiable. The state and federal warden system should be revised so that the collector and the sportsman shall be treated on the same basis. That is all I am pleading for. The laws and those officers whose duty it is to interpret and enforce them should *allow* collecting and regulate it, just as is done in the case of hunting. Those in high official position should recognize the claims of the private collector as well as the claims of the sportsman. We are responsible one to another for looking after each other's interests. Those at the top should have a care for the privileges of their minority constituency, wherever such privileges be not in serious conflict with the interests of the majority.

A further instance of inconsistency is to be noted in the intemperance with which the reservation idea has been put into effect within the last few years. The whole scheme of game refuges, and the reservation of restricted areas for safe breeding grounds for birds, is a splendid one. Its adoption on a large scale is a thing worthy of the deepest satisfaction on the part of naturalists, economists and sentimentalists alike. But hasn't it gone beyond all reason when the Aleutian chain of islands is closed absolutely to the collector; when St. Lazaria Island, southeastern Alaska, which to my knowledge has been visited by collectors just three times in twenty years, is suddenly declared a bird reservation and the regulations so fixed as to completely bar the taking of birds or birds' eggs for bona fide scientific purposes! It seems to me vastly more reasonable, economically, to put colonies of sea-birds under warden control, and at the same time to give the warden power of *allowing* moderate collecting and to see that such levy on the population is kept within the rate of productivity of the colony. It is exactly the same proposition as the gathering of mature timber from the forest reserve, or the shooting of moose and deer within certain safe numbers annually in Maine. A sea-bird colony, such as that on the Farallone Islands, would not suffer in the least if certain numbers of birds or eggs were gathered each year, totaling perhaps hundreds, just so these numbers were within the annual rate of increase. Such a course is absolutely the opposite of unlimited destruction, such as that waged by the plume-hunter. The latter violates the principles of conservation, which all men of science join with vigor in upholding.

Reasonable attention to several other factors, well known to collecting ornithologists, would far more than compensate for the toll taken by collectors. For instance, on the Farallone Islands the colonies of gulls are on the increase; the murres and cormorants are on the decrease, in spite of total protection, because of the piracy of the gulls. Many of the other birds on those islands would profit to a far greater degree if a considerable proportion of the gull population were eliminated. And this could be done easily through appropriate efforts on the part of a game warden at the beginning of the nesting season.

Collectors themselves probably fully compensate for the number of birds they destroy for specimens, in the incidental destruction by them of vermin. Collectors are practically the only people who can and do distinguish between the destructive and harmless hawks. The average collector can and does on all occasions destroy Cooper and Sharp-shinned Hawks, and in this way certainly makes up several times over for the small birds he shoots. Suggestive estimates could here be given as to the annual destruction wrought among both game and non-game birds by the few injurious species of hawks and owls. The predaceous blue-jays also receive the collector's attention.

It is true that collectors in the past have in

some instances behaved indifferently toward people who are sensitive to bird killing. This lack of sympathy on the part of the collector may be one factor that has brought him into disrepute. It is to be deplored. To control the thoughtless among collectors it is feasible to devise and enforce regulations, such as one to establish say a three-mile limit around all cities and even villages of a given minimum size. By similar action already taken in some states hunting is prohibited within specified distances of "public grounds." A system of local refuges and parks, where shooting for any purpose whatever would be prohibited, would certainly be approved by most collectors and would go far toward meeting the wishes of other lovers of living birds.

It should not be forgotten that the collecting ornithologist has furnished the bulk of the reliable data upon which our game laws are based, and upon which the economic value of our non-game birds has been established. Furthermore, the training involved in bird collecting can surely be given some credit in several cases of eminent men of science who are now valuable contributors to science in other fields. The making of natural-history collections is useful as a developmental factor, even if dropped after a few of the earlier years in a man's career. Collecting develops scientific capacity; it combines outdoor physical exercise with an appropriate proportion of mental effort, both enlivened with the zest of a most fascinating and at the same time widely suggestive line of enquiry.

As a rule, all collecting adds sooner or later to scientific knowledge, either directly through printed contributions from the collectors themselves, or through the subsequent study of the material by others, often after it has been acquired by some public institution. The ultimate fate of practically all private collections is the college or museum. Very few bird skins, for instance, are destroyed except through fire or other catastrophe. They live on and on, sources of added knowledge and instruction.

In conclusion let me urge that I consider judicious collecting absolutely indispensable to serious ornithological research along certain important lines, namely, faunistics, systematics, migration, and food studies. There is still an enormous amount of investigation to be done along these lines. Right now progress is perceptibly retarded, because the field of ornithology is being avoided or deserted by the younger students. This desertion is often due to difficulties in the way of securing permits and to lack of encouragement on the part of older men. The legal attitude toward collecting should be revised so as to take in the needs and proper demands of the collector, as well as those of the sportsman.

Joseph Grinnell
Museum of Vertebrate Zoology,
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THE SCIENTIFIC TREND IN SECONDARY SCHOOLS

A misconception regarding the trend in secondary education seems to have been incorporated in recent educational opinion. From the first citation[1] below, there is quoted the following (p. 80) referring to Mr. Fisher's article.[2]

> We note, therefore, the phenomenon of a decline in the ratio of students who elect science.

There can be no doubt that there has been a decline in the percentage of students electing physics, chemistry, physiography and physiology, as Mr. Fisher's graph shows, but that we are to conclude from these data that there is a decline in the sciences and an increase in the humanities is not so certain. It is quite possible that this decline in the enrolment in these subjects is explained by the shift of students with scientific interests to other subjects like botany, agriculture, domestic science, et cetera. Or it is conceivable that while the enrolment may decline, the length of time devoted to each subject is so in-

[1] Report of U. S. Commissioner of Education, 1913, Chap. V., "The Status of Secondary Education."

[2] "The Drift in Secondary Education," Willard J. Fisher, Science, November 1, 1912, N. S., Vol. XXXVI., No. 931.

creased that the total time devoted to it by all students remains a fairly constant factor. Combining the data for the sciences, the classics, the mathematics, the history and the English in the table from which Mr. Fisher obtained his data, namely, the "Summaries," on p. 1141 of the Commissioner of Education's "Report for 1910," we get the graph shown in Fig. 1 of this article. The lines

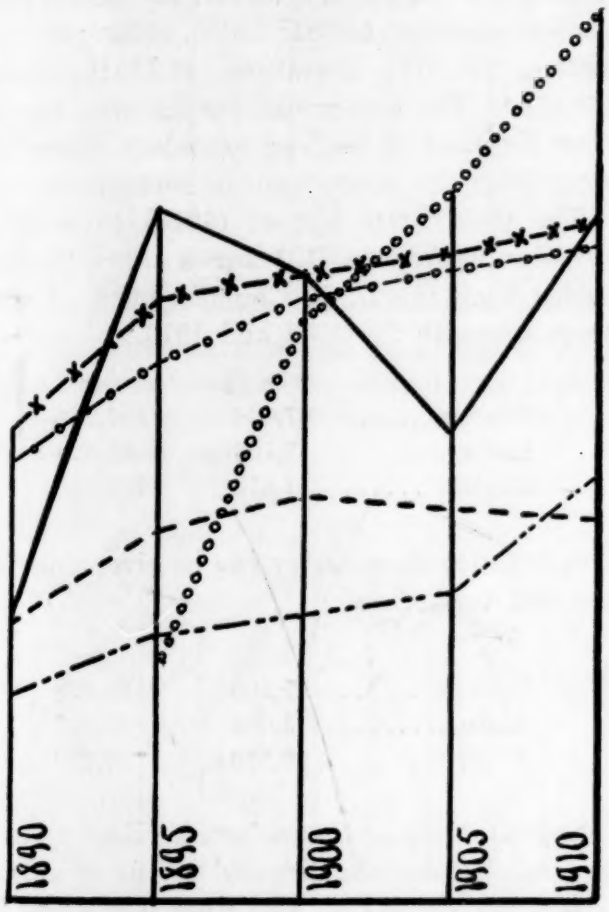

FIG. 1. Diagram shows percentage of total high-school enrollment in U. S. taking courses in mathematics —x—; foreign languages —o—; science —; classics - - -; history — - -, and English o o o. Data from tabulation, page 1,141, Report U. S. Commissioner of Education, 1910. 1 mm. = 1.2 per cent.

show the percentage of students taking these various subjects during the period of years from 1890 to 1910, inclusive. As far as the sciences, as a whole, go, it is evident that the data show that the enrolment in the sciences has increased much more rapidly than the enrolment in the classics and more rapidly than anything else in the tabulation except the English. I am aware that this conclusion is probably as unjustifiable as Mr. Fisher's because the data for the sciences are incomplete and the apparently erratic rise of the science line is due to the continued introduction of new data. Botany, zoology, agriculture and domestic science are apparently only of sufficient importance in recent years in the high-school curricula to have their enrolment reported. Yet the table gives the impression that the decline in physics, chemistry, et cetera, is due to the shift of students to these newer subjects.

I have examined with interest later reports of the Commissioner of Education to see if they confirm or contradict the conclusion to which Mr. Fisher comes, namely, that the sciences are declining in popularity with high-school students and that the humanities are constantly increasing their percentage of enrolment, but with the report of 1910 the commissioner ceased to print a statement of the enrolment in the various subjects, evidently appreciating the fact that such data, in the form in which they had been given, are more or less inconsequential. There is continued, however, the report of those graduates of public and private high schools who are preparing for college and who elect either the classical or the scientific course. These data are shown in Fig. 2. The first part of the chart gives the

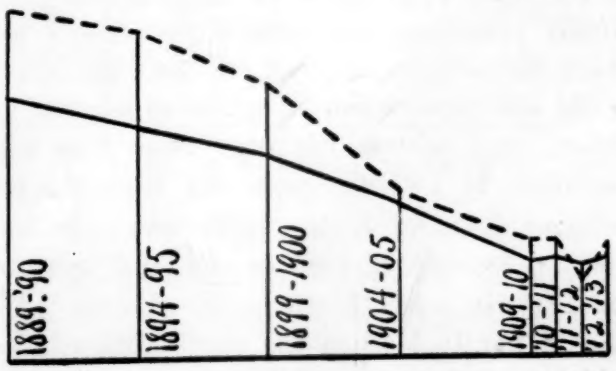

FIG. 2. Diagram shows percentage of high-school students going to college who select classical - - - and scientific —— courses. 1 cm. = 2.7 per cent. ———.

data for five-year periods; the latter part for yearly periods. Both the dotted line representing the percentage of classic students and

the solid line showing those in science are declining, indicating that the percentage of high-school students who go on to college is constantly diminishing, but, in so far as the graph throws light on our problem, it indicates that classical studies, among high-school graduates intending to go on to college, have been growing in disfavor more rapidly than the scientific.

The apparent increase, the country over, in the enrolment in Latin, and the decrease in physics, chemistry, physiology, et cetera, may be due to such changes in restricted regions which are not standing in a position of educational leadership. Such, I think, is the case, and hence I do not believe that the data Mr. Fisher uses can show the *trend* in modern secondary education. In the first place, the great increase in public high-school enrolment has been in the rural high schools. The sort of course in vogue there will determine, therefore, in large measure, the increasing enrolment in the various subjects. Mr. Fisher's second chart indicates that the percentage of population in public high schools has increased much more rapidly than the population of the United States, but that the rate of increase in urban high schools has been very slow. In other words, the drift which his figures might show is a drift that is found in the rural high schools. From 1890 to 1913 the percentage of the rural population (in cities of less than 8,000) attending the rural high schools has risen from 0.15 per cent. to 1.40 per cent., while the percentage of urban population in urban high schools has only risen fom 0.74 per cent. to 1.47 per cent. In 1890, the enrolment in rural high schools was only half (50.4 per cent.) of that in city high schools; in 1913 it was 11 per cent. greater. We should hardly look to the rural high schools, which have been established in such numbers in the last decade or two, to set the pace in educational matters. The trend in education would be much better indicated by the movements in the larger high schools and in the more progressive states. In the second place, in the decade from 1900 to 1910, 59.5 per cent. of the increase in high school attendance was in the North Atlantic states, a region still under the dominance of classic ideals in its smaller high schools. This fact would tend to make any reports including these figures show a dominance of the classics. Thus in Connecticut[3] the number of students pursuing various branches is given as follows: Modern language, 7,586; Latin and Greek, 5,947; mathematics, 12,070; literature, 21,429; science, 6,876. In Ohio, however, the figures are: modern language, 53,681; Latin, 45,023; mathematics, 200,875; literature, 61,755; science, 489,412.[4] Yet one would hardly even accuse New England of leading secondary education away from the sciences to the humanities.

The Ohio State Report (1913) gives comparative figures (p. 13) for a much shorter period than the U. S. Commissioner. I give them herewith for 1909 and 1913.

	1909	1913
Science	467,668	487,974
Latin	42,765	45,023
English	747,813	756,009

The data for New Jersey can be given only for the last two years.

	1912	1913
Science	17,509	22,478
Latin	15,003	13,147
English	28,540	32,230

These citations are not selected. Reports were requested from what seemed a fair sample of states, namely, N. H., Vt., Mass., Conn., N. Y., N. J., Pa., Ohio, Mich., Minn., Ia., Va., Md., Ky., Ga., Ore., Cal. The ones cited are the only ones among these which gave the desired information.

Not many of the states furnish, for a period of years, data regarding the enrolment in various subjects in the high schools. I give herewith the graph (Fig. 3) of the state of Minnesota, showing the percentage of the total enrolment in science, Latin and English. The percentage in mathematics and in the history group has remained at about the

[3] P. 228, "Report of the State Board of Education," 1910–11.

[4] Ohio School Report, 1913, p. 70–73.

same level. Minnesota will be free from the conservative classic tendencies of New England and her rural population has increased less than 10 per cent. in the last decade.

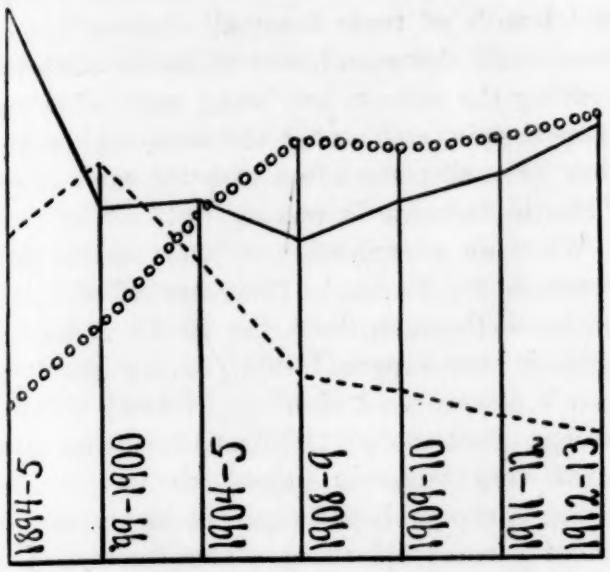

FIG. 3. Diagram shows the percentage of total high-school enrollment of Minnesota taking courses in science ——, Latin - - - and English o o o. 1 cm. = 3.5 per cent.

Another bit of evidence comes to hand in the "Report of the Bureau of Research of the Upper Peninsula Educational Association" (Michigan): Not a single high school requires Latin for graduation; three require a language; ten require science, three of these specifying that it must be physics; seven require neither science nor language; six did not report.

While these figures are all significant the enrolment in a given subject does not indicate the relative amount of time which is devoted to it. The enrolment, for instance, in a science might be the same as in Latin, but the science might continue only for a single semester while the Latin continued for the year. It would be possible, then, to measure the interest in a science group as compared with a language group only when the enrolment is expressed in commensurate terms.

I have had the opportunity recently to examine the records of the high school at Galva, Illinois. During the time covered by the graph given below (Fig. 4) the superintendent of schools has remained unchanged. No sudden change in the administration has, therefore, affected the curve. The enrolment has been figured in student-weeks. Thus, if twenty students take Latin for twenty weeks, the registration of the class would be considered eight hundred student-weeks. The graph given in Fig. 4 indicates the enrolment in science and in Latin and it is surprising how the two lines parallel each other. This, of course, is for a single school only, but it is the type of study which must settle the question as to the relative interest in science as compared with other subjects.

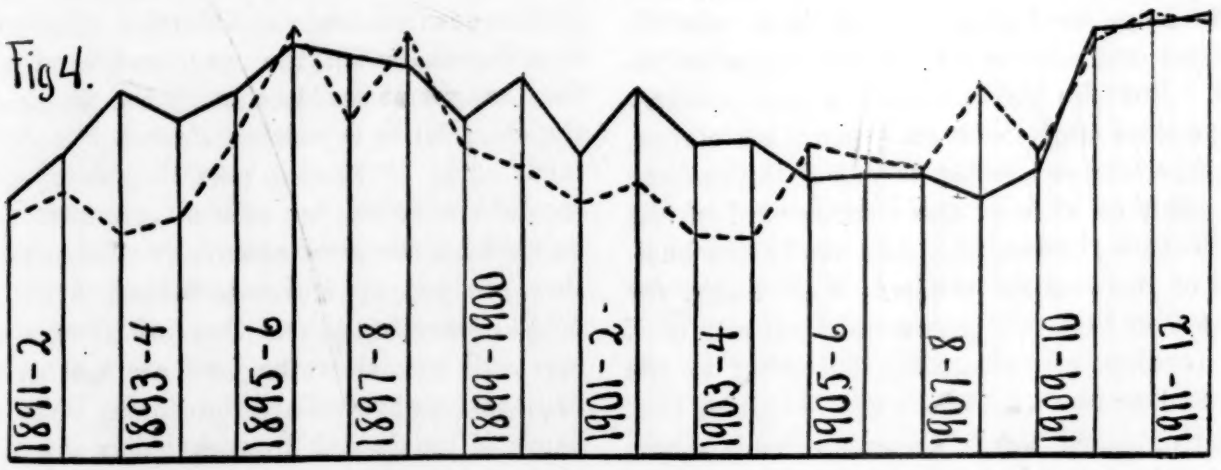

FIG. 4. ENROLLMENT IN SCIENCE —— AND LATIN - - - in the Galva, Ill., High School, expressed in student-weeks. 1 mm. = 33 student-weeks.

ELLIOT R. DOWNING
THE UNIVERSITY OF CHICAGO

PATRONIZING THE SOUTH AMERICAN REPUBLICS

The report made by Mr. Bard to the trustees of the Carnegie Endowment for Peace[1] describes a tour of South America made by a party of twelve young men from our universities, and one naturally inquires what the party proposes to do in behalf of international peace. The purposes of the expedition seem to have been comprehensive—remarkably so, in fact—though nothing is said specifically about peace. It is inferred that peaceful ends are to be attained through the cultivation of friendly relations in general and by the building up of North American commerce with South America. Any one who has much personal acquaintance with South American peoples and conditions is necessarily interested in such expeditions.

It is fully realized nowadays that neither persons nor peoples can be friends unless they have some acquaintance with each other, and we are bound to think well of any effort that really helps, or seems likely to help, towards a better acquaintance with our Latin neighbors. But the discoverer of a new country aways does well to be modest in his claims, and, in so far as possible, to look at things from the point of view of the country and of the people thus discovered. And really the business of discovering people is a bit risky, for the reason that they may not be entirely new, nor is discovery altogether flattering to the people discovered. A while ago Mr. John Doe, a distinguished North American, made a trip to South America, where he was kindly received and handsomely treated, and when he came home he gravely announced that South America was waking up. A gentleman who had known that part of the world for a great many years received the statement with the quiet remark: "I suspect that it is Mr. John Doe who is waking up."

[1] "Intellectual and Cultural Relations between the United States and the Other Republics of America," by Harry Erwin Bard. Publication No. 5, Carnegie Endowment for International Peace; Division of Intercourse and Education. 8vo, 35 pages. Washington, 1914.

But Mr. Doe's discovery was not the first one, nor yet is it the last one. Various societies for the promotion of all sorts of things, and boards of trade from all sorts of places, have made the grand tour of South America, visiting the same cities, being received by the same people, and seeing the same sights, and they have all come home with the same story: "South America is waking up!"

When an organization of such serious purposes as the Carnegie Endowment for International Peace entered the South American field, it was supposed that, having grown to man's estate, we had now put away childish things. But though this last expedition takes itself very seriously indeed, the program as given in the published report looks remarkably like the same old thing. The description of the experiences of one of these junketing expeditions is much the same as that of any other. They make known their coming beforehand in the countries to be visited, and the program is about the same for one as for another. Greetings are wired back and forth from various stopping-places on the way, and even while they are yet at sea, so that by the time one of the chief cities is reached the whole nation is fairly agog. Arrived in port, they are met with special launches by official committees appointed by the government, at whose expense they are put up and entertained at the best hotels; traveling inland they are given special cars and special trains, and are met at railway stations by various dignitaries, often with bands of music and fireworks; they are driven about in the finest of motors; they are shown all the showy sights of the cities they visit; they are taken to the operas at public expense; refreshments are served them on all possible occasions; they are banqueted and toasted and hear beautiful complimentary speeches and deliver a few themselves; and finally, loaded with presents, pictures and publications (p. 17) they get back on board their steamers (at government expense again), where they settle down in their comfortable steamer chairs, profoundly impressed with their own importance and by the sensations they are evidently creating. And all these manifesta-

tions of the warm-hearted, polite and generous hospitality of the Latin peoples our representatives accept as evidences of the "waking up" of South America, and as tributes to our general superiority, sagacity and superhumanity.

Thus encouraged, these representatives of ours—these innocents abroad—generally open their hearts and give their hosts the benefit of their wisdom and patronage. In the present case it was suggested to a minister and also to a president that a certain group of teachers would like to visit the United States and the Panama Exposition, "and they seemed pleased with the idea" (p. 12). And such a new idea too, and one that would cost so little—to us! Of the city of S. Paulo, Brazil, it is said that the "people show intelligence and purpose in all their movements" (p. 8). How it must please the people of Brazil to be told that they show intelligence and purpose! It is frankly stated that the chief aim of the party was to "make favorable impressions everywhere," and it is believed that the general impressions on both sides were good (p. 20), while everywhere they found eagerness for "closer intellectual and cultural relations with the people of the United States" (pp. 8, 15, 19).

Is it any wonder that the utility of such expeditions is questioned? What do these young men know, and what can they reasonably expect to learn in the few strenuous days spent among them, of the grain, the traditions and the point of view of the people of South America? This particular expedition spent eight days in Brazil, three days in Uruguay, six days in Argentina, nine days in Chile, and one day in Peru—just twenty-seven days on the continent of South America! The author of the report lays stress on "the experience and knowledge gained on this trip" (p. 20), while some fear is expressed lest "this golden opportunity for mutual service may pass without profit" (p. 20)—a fear that we cordially share with the members of the party.

Evidently it is not realized by those who are responsible for them that such excursions tend to discredit the very men— their fellow-countrymen—who have lived for years in South American countries, who must of a necessity form the very groundwork of any future business we can reasonably hope to develop; for they are the ones who have built up good reputations and sound business by right living and right dealing, and who do more for North American trade than all the junketing expeditions and drum-beating delegations ever sent out either by public or by other organizations whose judgment is not on the proper footing with their good intentions.

Our profound ignorance of Latin America is not to be whitewashed over by such processes; nor are the people of South America of the kind to be taken in with a lot of colored glass beads or palaver.

There are a few fundamental principles that should be called to the serious attention of those who are responsible for such expeditions as this one, or for efforts of any kind to cultivate trade or friendly relations with South America:

First, business relations and business confidence in South America are things of slow growth, just as they are in other parts of the world.

Second, the experience of residents, and authorities who have spent their lives in studying and meeting the conditions of commerce and intercourse can not safely or justly be brushed aside and disregarded.

Third, if the people of Latin America are to be patronized and talked down to, our efforts to gain their confidence or to establish cordial relations with them will never meet with any genuine success.

JOHN CASPER BRANNER
STANFORD UNIVERSITY, CALIF.,
January 8, 1915

A NEW FIELD SCHOOL OF GEOLOGY FOR HARVARD UNIVERSITY

AT a meeting of the visiting committee of the department of geology and geography held with the members of the staff on January 30, plans were presented and approved for extending the field work conducted by the department during the summer months. Professor Wallace W. Atwood, who recently re-

signed from the University of Chicago to join the Harvard staff, will have charge of this new work, and during the summer of 1915 will establish a camp in the San Juan Mountains of southwestern Colorado. Five weeks of introduction will be given, beginning early in August and closing about the tenth of September, and this course will be credited at Harvard University towards a degree.

The party will be limited in number, and opened only to those men who have had at least an introductory college course in geology. Under the direction of Dr. Atwood the party will actually conduct a piece of geological survey work, and at the close of the season have the opportunity of an expedition through the high mountain area. The field chosen is remarkably rich in its range of geological phenomena, in mining interests, and in scenic features. The equipment of the camp is provided for by funds furnished by the visiting committee of the department which will reduce the cost to each student to his share of the actual living and moving expenses associated with the camp, and it is estimated that these expenses will not exceed one hundred dollars for each member.

Applications for membership in this party should be addressed to Wallace W. Atwood, Harvard University, Cambridge, Mass., before May 1, 1915.

The usual field work offered in Montana and conducted under the endowment of Robert W. Sayles and under the direction of Professor J. B. Woodworth will be offered during the coming summer. That work will begin early in July, and close in time to permit those who wish to join the Colorado party. The combination of the two courses permits the student to spend ten weeks under instruction in the Rocky Mountains during the coming field season.

The following members of the visiting committee were present at the meeting when these plans were approved: Messrs. George B. Leighton, George P. Gardner, Guerdon S. Holden, Livingston Davis and J. Walter Wood.

THE SUMMER MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA

The society has accepted the invitation of the authorities of the University of California and Leland Stanford Jr. University to hold a special meeting at Berkeley and Stanford University, August 2–7, 1915, in affiliation with the American Association for the Advancement of Science. The following topics have been selected for particular discussion during the geological meetings: (1) Erosion and deposition in arid climates; (2) Diastrophism of the Pacific Coast; (3) Petrological problems of the Pacific area.

The sessions of Monday and Tuesday will be held at the University of California and that of August 4 at Stanford University.

Excursions under the leadership of local geologists will be organized during the remaining days of the week as follows:

Thursday, August 5, to Point Reyes Station, Marin County, for an examination of the San Andreas earthquake rift.

Friday, August 6, to Mussel Rock, San Mateo County, by the Ocean Shore Railway, for an examination of Pliocene strata, the type section of the Merced formation and post-Tertiary deformations of the coast.

Saturday, August 7, two excursions will be provided; one by the Oakland, Antioch & Eastern Railway (electric) to Mount Diablo for an examination of the Mount Diablo overthrust and the succession of Tertiary strata; and the second to Santa Cruz by the Southern Pacific Railway for an examination of uplifted marine terraces.

More extensive excursions may be arranged for the week following the meeting.

Edmund Otis Hovey,
Secretary

SCIENTIFIC NOTES AND NEWS

Dr. Adolf von Baeyer, professor of chemistry at Munich, being eighty years of age, has retired from the active duties of his chair.

The Daly Medal of the American Geographical Society has been awarded to M. Paul Vidal de la Blache, professor of geography at the Sorbonne, Paris.

PROFESSOR A. BRILL, of the University of Tübingen, and M. Planck, of the University of Berlin, have been elected members of the Accademia dei Lincei of Rome.

DR. J. A. MURRAY has been appointed acting director of the British Imperial Cancer Research Fund.

DR. THEOBALD SMITH went last week to Chicago to investigate conditions among cattle that are suffering from foot and mouth disease. Dr. Smith met members of the faculty at the University of Illinois and made suggestions as to the handling of the situation by state authorities.

LEAVE of absence has been given by Royal College of Surgeons, London, to the conservator, Professor Arthur Keith, for six weeks, for the purpose of going to America to deliver a course of five lectures on anthropology at the Western Reserve University, Cleveland, Ohio.

PROFESSOR FRANCIS E. LLOYD, of McGill University, has, on account of impaired health, been granted leave of absence for the remainder of the present session. His address until September will be Carmel, California.

PROFESSOR JOHN DUTTON WRIGHT, of the Wright Oral School for the Deaf of New York City, has been elected a director of The American Association to Promote the Teaching of Speech to the Deaf.

CAPTAIN H. G. LYONS, F.R.S., has been elected president of the Royal Meteorological Society and Mr. F. Campbell Bayard and Commander W. F. Caborne secretaries for the ensuing year. The new members of the council are Mr. J. S. Dines, Mr. A. P. Jenkin and Sir J. W. Moore.

THE officers of the various sections of the New York Academy of Medicine for the year 1915 are as follows: Dermatology and syphilis, Dr. Charles M. Williams, chairman, Dr. Walter J. Heimann, secretary; surgery, Dr. Clarence A. McWilliams, chairman, Dr. John Douglas, secretary; neurology and psychiatry, Dr. Israel Strauss, chairman, Dr. Foster Kennedy, secretary; pediatrics, Dr. Walter L. Carr, chairman, Dr. Royal S. Haynes, secretary; otology, Dr. C. D. Van Wagenen, chairman, Dr. John A. Robinson, secretary; ophthalmology, Dr. H. H. Tyson, chairman, Dr. George H. Bell, secretary; medicine, Dr. T. Stuart Hart, chairman, Dr. Nellis B. Foster, secretary; genito-urinary diseases, Dr. Leo Buerger, chairman, Dr. A. R. Stevens, secretary; orthopedic surgery, Dr. Arthur H. Cilley, chairman, Dr. P. W. Roberts, secretary; obstetrics and gynecology, Dr. LeRoy Broun, chairman, Dr. George W. Kosmak, secretary; laryngology and rhinology, Dr. Hubert Arrowsmith, chairman, Dr. Francis W. White, secretary.

ON the Richard B. Westbrook Free Lectureship of the Wagner Free Institute of Science, four lectures on Invisible Light, illustrated with experiments and lantern slides, are being given by Professor Robert Williams Wood, of the Johns Hopkins University, on Tuesdays, February 9, 16 and 23 and March 2.

AT the regular monthly meeting of the Cosmos Club, Washington, on February 8, General A. W. Greeley delivered an address on "The Continent of Antarctica."

PROFESSOR J. C. BOSE, of Calcutta, India, gave two lectures toward the end of January at the University of Illinois, the first on "Plant Autographs and their Revelations," the second on "The Curve of Life and Death."

THE annual Samuel D. Gross lecture has been delivered at the Jefferson Hospital, Philadelphia, by J. Chalmers Da Costa, professor of surgery at the Jefferson Medical College.

THE Galton dinner and lecture instituted last year by the Eugenics Education Society in honor of the memory of Sir Francis Galton, will be held this year, as before, on the anniversary of his birth, February 16. Professor J. A. Thomson will deliver a lecture which will deal with eugenics and the war.

WE learn from *Nature* that Professor George Forbes, who has been entrusted by Lady Gill with the duty of preparing a memoir of her late husband, would be glad to be favored with any letters which have been pre-

served by Sir David Gill's numerous correspondents; and would greatly appreciate any notes—narrative, historical, appreciative or anecdotal—relating to Sir David's life and personality. All original letters or other documents will be carefully preserved, and returned to the senders at as early a date as possible. Such communications should be addressed to Professor Forbes at 11 Little College Street, Westminster.

The death is announced of Dr. Anthony Woodward, at one time assistant in the department of geology and for thirty-seven years librarian of the American Museum of Natural History, New York City.

M. Alfred Tournier, formerly professor of viticulture at the University of California and later connected with the U. S. Department of Agriculture, was killed on December 12 in the war.

Vice-admiral Sir George Nares, K.C.B., F.R.S., the distinguished British navigator, commander of the *Challenger* and of Arctic and other scientific expeditions, died on January 15, at the age of eighty-four years.

Mr. J. S. Harding, connected with the British Meteorological Office from its establishment in 1854, until his retirement in 1906, died on January 11, at the age of seventy-five years.

Dr. Otto Rüsslin, professor of zoology in the Technical School at Karlsruhe, has died at the age of sixty-five years.

Professor J. Rosenthal, professor of physiology at Erlangen, has died at the age of seventy-seven years.

Dr. Karl Liebermann, professor of organic chemistry at Berlin, has died at the age of seventy-two years.

Dr. Otto Scheuer, docent for applied chemistry at Geneva, has been killed while serving in the Austrian army.

Among the examinations announced by the New York State civil service commission on February 27 is one for assistant in paleontology in the state museum, at a salary of $1,200. Candidates must be graduates of an approved college with some experience in museum work. They should also be able to pass an examination covering the following: The principles and elements of general geology; the principles and elements of stratigraphic geology or stratigraphy, with definite knowledge of the classification of the geological formations, more specially and in some detail, those of the Paleozoic system; the principles and elements of general biology; the elements of zoology, specially of the branches herewith named: morphology and classification of animals; embryology; the theories and demonstrations of phylogeny and evolution; the principles and elements of botany with special reference to classification; familiarity with the local flora and the histology of trees.

The Royal Academy of Medicine of Turin announces that the thirteenth Riberi prize of the value of £800 is offered for the best medical research work presented before December 31, 1916. Particulars may be obtained from Dr. V. Oliva, secretary of the academy.

An emergency appropriation of $10,000 was made by the Kansas legislature on February 2 to finance the fight of the state against the foot and mouth disease in four counties under federal quarantine. The action followed a special message from Governor Capper asking the appropriation.

According to the London correspondent of the *Journal* of the American Medical Association the scarcity of physicians created by the war is illustrated by the statement of the secretary of the Wolverhampton General Hospital, at a meeting of the committee. He could well remember the time when it was quite a common thing, when they advertised for a house surgeon or physician, to receive from ten to twenty applications for one post. Things gradually became worse, however, until, advertise as they would, they absolutely failed to get any applications for the post vacant. He was sent off to London and visited nine of the leading medical schools, and the result was that after extreme difficulty the resident post was filled. As soon as it was known that medical officers were wanted in the army and navy,

all the resident medical staff volunteered. On two occasions it had been impossible for members of the honorary staff to see all the outpatients. He had gone to London again, and did the round of the medical schools. He could not find a single man who wanted employment as a doctor, and theirs was not the only hospital in such a position. They had had to fall back on medical women. But though obtainable, they too were scarce. Their resident staff now consists of one man and three women.

MR. WM. BARCLAY PARSONS has written to the editor of the New York *Times* as follows: "The recent accomplishing of transmitting speech between New York and San Francisco is an event that rightly has attracted public attention. It is an achievement of the very highest importance, and reflects great credit on all concerned. It is, however, a matter of great surprise that in no New York newspaper that I have seen has any mention been made of the man to whom the scientific honor is wholly due. Even the president himself congratulated Mr. Bell upon his accomplishment, overlooking the fact that the instruments used to send and receive the first transcontinental message were those used forty years ago, showing that whatever advance was indicated by the transmission of speech over 3,400 miles of wire was not due to the instruments at the ends. This great and heretofore never-accomplished feat is due entirely to the work of Professor Michael I. Pupin, of Columbia University, who, by certain simple devices, has made possible the use of long wires in telephony. Although the devices themselves are simple, their design was reached only after the most painstaking and elaborate mathematical analysis. The final result is intensely practical, but it is based on work of the highest order of pure science."

WITH a view of acquainting the public with the standards, and the results of recent experiments conducted on standardized raw cotton, the division of textiles of the U. S. National Museum has recently placed on exhibition in the cotton section the nine official grades of white American upland raw cotton; also a series of samples of the waste cotton obtained from standardized graded cotton, and samples of No. 22's warp yarn made from the five standard full grades of raw upland cotton. The principal factors which mark the grade of a cotton are (1) the foreign matter or impurities, such as broken leaves, dirt, sand, strings, motes, naps, gin-cut fiber, etc., contained therein, and (2) color. The differences between the several grades can be determined only by the trained eye, but the lowering of the grade due to increasing amounts of foreign matter can be made evident by showing the actual amount of waste material obtained from a definite quantity of cotton. To demonstrate these differences, a certain quantity of graded cotton was carried through the regular operations preparatory to spinning, the amount of waste produced in each operation being carefully preserved, labeled and arranged in exhibition boxes. The series of samples illustrating these experiments, now on exhibition in the National Museum, begins with a box containing four samples, each of the five full grades of Standard Atlantic States Upland Cotton, showing "Good Ordinary," "Low Middling," "Middling," "Good Middling" and "Middling Fair," the last of which is the highest grade. The second series illustrates upland cotton picker waste, and comprises one sample from each of the five full grades of standard upland cotton extracted by the machines employed in opening and preparing raw cotton for the carding machine. The picker waste is thrown out by the four following machines: the preparer or opener, the breaker, the intermediate and the finisher. The third series comprises a box containing one sample each of card motes, card fly and card strippings, from the five full grades of standard upland cotton, and shows the matter thrown out as waste in carding raw cotton. The final box includes one sample of yarn spun from gray and bleached raw stock of each of the five grades of standardized eastern and western upland cotton and comprises 20 samples in all. Although the standard grades of cotton were established by the government some time ago, this is the first exhibit show-

ing the waste from the various processes of manufacture through which cotton passes.

The fuel value of two pounds of wood is roughly equivalent to that of one pound of coal. This is given as the result of certain calculations now being made in the forest service laboratory, which show also about how many cords of certain kinds of wood are required to obtain an amount of heat equal to that in a ton of coal. Certain kinds of wood, such as hickory, oak, beech, birch, hard maple, ash, elm, locust, longleaf pine and cherry, have fairly high heat values, and only one cord of seasoned wood of these species is required to equal one ton of good coal. It takes a cord and a half of shortleaf pine, hemlock, red gum, Douglas fir, sycamore and soft maple to equal a ton of coal, and two cords of cedar, redwood, popular, catalpa, Norway pine, cypress, basswood, spruce and white pine. Equal weights of dry, non-resinous woods, however, are said to have practically the same heat value regardless of species, and as a consequence it can be stated as a general proposition that the heavier the wood the more heat to the cord. Weight for weight, however, there is very little difference between various species; the average heat for all that have been calculated is 4,600 calories, or heat units, per kilogram. A kilogram of resin will develop 9,400 heat units, or about twice the average for wood. As a consequence, resinous woods have a greater heat value per pound than non-resinous woods, and this increased value varies, of course, with the resin content. The available heat value of a cord of wood depends on many different factors. It has a relation not only to the amount of resin it contains but to the amount of moisture present. Furthermore, cords vary as to the amount of solid wood they contain, even when they are of the standard dimension and occupy 128 cubic feet of space. A certain proportion of this space is made up of air spaces between the sticks, and this air space may be considerable in a cord made of twisted, crooked and knotty sticks. Out of the 128 cubic feet, a fair average of solid wood is about 80 cubic feet. It is pointed out, however, that heat value is not the only test of usefulness in fuel wood and since 95 per cent. of all wood used for fuel is consumed for domestic purposes, largely in farm houses, such factors as rapidity of burning and ease of lighting are important. Each section of the country has its favored woods and these are said to be, in general, the right ones to use. Hickory, of the non-resinous woods, has the highest fuel value per unit volume of wood, and has other advantages. It burns evenly, and, as housewives say, holds the heat. The oaks come next, followed by beech, birch and maple. Pine has a relatively low heat value per unit volume, but has other advantages. It ignites readily and gives out a quick hot flame, but one that soon dies down. This makes it a favorite with rural housekeepers as a summer wood, because it is particularly adapted for hot days in the kitchen. The fuel qualities of chestnut adapt it particularly to work in brass foundries, where it gives just the required amount of heat and it is therefore in favor. Coastwise vessels in Florida pay twice as much for Florida buttonwood as for any other, because it burns with an even heat and with a minimum amount of smoke and ash. The principal disadvantage of the resinous pines is their oily black smoke.

The museum of the California Academy of Sciences has received as a gift the large collection of marine, freshwater and land shells assembled by the late Henry Hemphill. The generous donor is Mrs. Charlotte Hosmer, of Oakland, California, the daughter of Mr. Hemphill. The collection contains between 60,000 and 70,000 specimens, representing 12,000 to 15,000 species, and is particularly rich in west coast species. The museum of the academy has also recently acquired the entire Lowe collection of Indian baskets, pottery, stone implements, Navaho and Chilkat blankets, and miscellaneous objects of Indian manufacture and use. This collection comprises more than 1,500 Indian baskets, and several hundred pieces of pottery and miscellaneous objects. The collection of baskets, which is said to be one of the most complete and valuable in existence relating to the

Pacific coast tribes, is the result of many years devoted to the subject by the late Professor and Mrs. T. S. C. Lowe, of Pasadena. The collection comes to the academy as an indefinite loan through the generosity of Hon. Wm. M. Fitzhugh, of San Francisco. Mr. Fitzhugh not only gives the collection, but will also meet all the expenses of labeling, card cataloguing, providing cases of the best type and installing the collection in the academy's new museum building now under construction in Golden Gate Park.

BY an amendment to the by-laws recently adopted by the Academy of Natural Sciences of Philadelphia, the members can now borrow certain books to be designated by the librarian and the library committee. The library has been exclusively for reference, no one having been allowed to take books from the building, since 1859.

THERE has been a decline of more than 6,000 applications for patents during 1914 in Great Britain. Whereas in 1913 the number of patents applied for was over 31,000—practically the same as the preceding year—the total of 1914 amounts to barely 25,000. The causes of this falling off are said to be the interference with certain trades consequent upon the war and the cessation of applications from hostile countries. As these causes apply to only the last five months of the year, the decrease during that period amounts to about one half.

A SERIES of six popular demonstrations in science has been arranged by Syracuse University and the Technology Club of Syracuse, as follows:

January 14—The production and application of electricity: Dean William P. Graham, of Smith College of Applied Science.

January 21—Some of our common birds and how they are helpful or harmful: Dr. Chas. C. Adams, forest zoologist of the New York State College of Forestry.

January 28—Bacteria, friends and foes: Professor H. N. Jones, of the department of bacteriology, Syracuse University.

February 4—Gas engines—their construction and operation: Mr. George Babcock, expert with the Franklin Automobile Co.

February 11—How timber decays and how this decay may be prevented: Dean Hugh P. Baker, of the New York State College of Forestry.

February 18—Illuminating and other gases and how they are produced and used in our industries: Dr. E. N. Pattee and Professor C. R. Hoover, of the department of chemistry of Syracuse University.

UNIVERSITY AND EDUCATIONAL NEWS

MR. GEORGE SKELTON YUILL, of London and Australia, has given a sum of $20,000 to the University of Aberdeen to found a scholarship in chemistry in the memory of the arts class of 1864–68, of which he was a member. The scholarship will be held by a student of the university for the purpose of research within it, or for the study of the practical applications of chemistry elsewhere. Mr. James Campbell, LL.D., chairman of the governors of the North of Scotland College of Agriculture, has founded four bursaries or scholarships to be held by students of the university in the college.

IT is stated that there are this year matriculated in the University of Berlin 7,037 men and 898 women, as compared with 8,200 men and 859 women last winter.

DR. WILLIAM H. PARK has offered his resignation as dean of the New York University Medical College because of the ruling of the department of health that its department heads shall not hold administrative positions elsewhere. Dr. Park is director of laboratories. He will retain his position as professor of bacteriology and hygiene in the college.

PROFESSOR DE LA VALLÉE POUSSIN, of the University of Louvain, will, as has already been announced, give a course of lectures at Harvard University. The lectures which will be in French are on Lebesque Integrals. The first lecture will be given on February 16 and the course will be given twice (possible three times) a week throughout the remainder of the academic year. There will also be supplementary lectures and explanations in English by Dr. Dunham Jackson.

Professor R. M. Barton, of the University of New Mexico, has been appointed professor of mathematics in Lombard College.

DISCUSSION AND CORRESPONDENCE

THE RATE OF CONTINENTAL DENUDATION[1]

In an article bearing the above title, published in Science, December 25, 1914, Charles Keyes contends that determinations of mineral matter carried by such streams as the Mississippi are of little or no value, particularly as a basis for estimates of "the rate of lowering of the continental surface through stream corrasion" (and transportation?). To the present writer it seems that the article as a whole and most of the individual statements in it are likely to give many readers a wrong impression, and that some of the statements, for example that "The elaborate stream measurements thus go for naught" are altogether and demonstrably untrue.

The great practical value of the water analyses is too obvious to need elucidation. They are essential in water-supply problems almost innumerable, especially in connection with providing water for industrial and municipal use, and for irrigation; in fact they were made primarily for use in solving just such problems, not "with the express purpose of determining the rate of lowering" of the land surface. The measurements of stream discharge that have been utilized in calculating the rates of denudation furnish the basic data for many of the greatest public and private hydraulic developments in the United States.

The educational value of the data afforded by these determinations is equally obvious. That the Mississippi is gathering from the surface, mostly from the soil, of its own basin several hundred million tons of earthy material every year and is dumping this material into the Gulf of Mexico; that practically none of this material is being returned; that some parts of the basin are losing by stream action more rapidly than others; that the earth's surface everywhere is being continually modified by such action—valleys carved, hills razed, and so on—these are not facts that it is worthless to ascertain.

Apparently Mr. Keyes wishes to convince his readers that the stream observations that he assails are futile because the effects of stream action are modified by internal earth movements and by the introduction of wind-blown materials.

That parts of the Mississippi basin have been uplifted in past geologic time is a matter of common knowledge, but the writer does not see that it affects the precision of conclusions regarding the amount of material now being removed by the streams. The statement that "Since Glacial times—perhaps 10,000 years ago—a very considerable part of the upper Mississippi Valley appears to have been elevated not less than 500 or 600 feet" must have reference to the remarkable work of late years on raised Pleistocene beaches of the Great Lakes, but the published reports on this work indicate that only a small part of the Mississippi Valley has been affected by the uplift, and none of it so much as 500 or 600 feet. The 500- and 600-foot isobases lie entirely outside of the Mississippi basin in the vicinities of Lake Superior and Quebec.

As to wind deposits, it should be remembered that strata of other than wind origin lie at or near the surface throughout the Mississippi basin, whereas if dust had been accumulating "over the entire Mississippi Valley faster than the river and its tributaries are carrying rock waste to the sea," water-laid and ice-laid materials would not outcrop but would be deeply buried under eolian dust instead of under products of their own decomposition. That large quantities of material have been and are being shifted by the wind no one doubts. The literature on the subject is voluminous, as is shown by the excellent bibliography compiled by Stuntz and Free, and many precise data have been recorded. For example, J. A. Udden calculated in 1894 that the capacity of the atmosphere over the Mississippi basin to transport dust may be a thousand times that of the river, but he did not fail to observe that the actual load carried by the air is "an insignificant fraction" of its capacity load. Dust, however, is shifted back

[1] Published by permission of the Director, U. S. Geological Survey.

and forth in the basin by the wind, whereas stream sediment and dissolved matter travel in one direction only. It is well known that in drawing conclusions regarding the rate of denudation account should be taken of the material transported by wind. Attention was called to this factor of the problem by E. E. Free in an article published in SCIENCE, March 12, 1909, but it is difficult to comprehend how conclusions as to the "rate of lowering of the continental surface through stream corrasion" are affected by aerial transportation. (Erosion rather than corrasion is probably here meant, for corrasion does not include transportation.)

In the fourth paragraph of his article Mr. Keyes speaks of wind-blown dust and then says:

> In recent geologic times also, the western half of the basin has actually had deposits laid down upon its surface to a thickness of not less than 1,000 feet.

Now if "recent geologic times" means most of the Tertiary and Quaternary periods (of which *Recent* time is but a small part); if the "western half of the basin" means a part of the western half of the basin; and if "deposits" means not only wind deposits (loess and sand) but also and predominantly aqueous deposits, the statement would appear to be in accord with the facts. Nevertheless it might still be characterized as trite and irrelevant, for the existence of Tertiary and Quaternary strata in the western part of the basin is well known and the commonly accepted conclusion that the great western tributary, Missouri River, carries 150 to 200 million tons of mineral matter out of its drainage basin every year is on just as firm a basis as before.

EUGENE WESLEY SHAW

ALBINISM IN THE ENGLISH SPARROW

TO THE EDITOR OF SCIENCE: The note in SCIENCE of January 1, concerning albinism in the English sparrow recalls several observations made by the present writer at various times. Semi-albinism, or spotting, or mottling with white in the plumage of these birds is not at all rare, though of course not particularly conspicuous unless one is especially used to the study of birds in the open. I have seen this feature among these sparrows both in this country and in Europe at several times and places. But complete albinism is less common, though not so rare as the note referred to above might imply. A number of years ago in Oxford, Ohio, I found in a brood of sparrows just in flight from the nest three specimens which were perfectly white, and with the characteristic pink eyes of the pure albino. Two of these birds I was able to capture, the other escaped. Two of the same brood were quite normal in plumage. Neither of the parent birds was an albino, and so far as one could know the phenomenon was quite spontaneous in this brood. Another case which came to my knowledge quite recently was in Syracuse. In this case a single specimen was observed by school children of one of the grammar schools of the city who at once ran to the teacher with the news, and the teacher having seen it communicated with me as to the significance of a feature quite new to her. While I did not see this specimen myself, the validity of the case is beyond doubt and may be accepted as another example of the phenomenon.

In this connection it may be well to call attention to several cases of partial albinism which I have noted in the common robin. Several years ago I found such a female robin brooding a nest near my house and I took pains to watch the outcome. None of the young gave any indication of white plumage. Another case has come under observation in a park adjoining my present home in Syracuse. Here again, the robin was a female, and had a conspicuous patch of white feathers on the back and shoulder. The specimen has been noted now for three successive summers, and though careful attention has been directed to the young no evidence of similar markings has been noted. Albinism being a recessive character tends to disappear under ordinary conditions of mating, hence its comparative rarity in a state of nature.

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SCIENTIFIC BOOKS

Leçons sur les Fonctions de Lignes. Professées à la Sorbonne en 1912, par Vito Volterra, recueillies et rédigées par Joseph Pérès. Paris, Gauthier Villars, 1913.

The point of view of this book of Volterra's is the systematic generalization of systems of relations of simple type by means of a passage from finite to infinite. We are already familiar with this procedure, in the subject of integral equations, first in the work of Volterra himself, suggested then in the work of Fredholm, and minutely worked out in the papers of Hilbert, his associates and students. But whereas perhaps Hilbert has limited himself to a few aspects of the question and rigorously justified the passage from finite to infinite, considering the subject of forms in an infinite number of variables as a subject for investigation in itself, Volterra has made wide application of an heuristic device for the purpose of obtaining results, which can then sometimes more simply be justified by methods proper to the new subjects themselves. This device is as old as the idea of infinitesimals.

After mentioning the familiar generalizations of this kind, of sum and product, Volterra considers briefly the subject of the generalization of the multiplication of substitutions, coordinate with the integration of linear differential equations, and then devotes the pages of the book proper to the generalization of the idea of function of several variables. This generalization involves the general principles of the study of functional relations.

We are concerned then, in the limit, with the investigation of functions which depend on an infinite number of variables—in particular, on all the points of a curve, or on all the values of another function throughout a certain interval. The general method of making such a study is by procedure from the finite to the infinite.

As an illustration of such a procedure, Volterra cites, in the Introduction, a treatment of the restricted problem of three bodies, by the application of Cauchy's method. The motion of the small body, the only one not known, can be determined by summing the motions obtained by considering the larger bodies as temporarily fixed at various points of their orbits, and proceeding to the limit as these various points on each orbit are taken closer and closer together.

Another passage of the Introduction relates to the definition of the derivative of a function of a curve, and is worth while quoting, since in this case the example is proper to our subject itself. "If a quantity depends upon a curve, we can study the effect produced on the quantity by a variation of the curve. If this variation is very small and limited to the neighborhood of a point of the curve, we arrive at the notion of derivative.[1] For each point of the curve we shall in this way have a derivative. By superposing such variations of the curve, made in all its points, we find the differential, or variation, of the quantity, which will be expressed by means of an integral; in fact, since a function of a curve is a function of an infinite number of variables, the sum which expresses the differential of a function of several variables leads, by the passage to the infinite, to an integral.

"We can then take up the study of differentials of higher order, and thus come to an analytic development analogous to the Taylor's series. The simple double and triple sums, etc., which occur in the development of a function of several variables, are replaced by simple, double, triple, etc., integrals."

The character of this analysis is thus shown. Its purpose is to investigate the phenomena of hysteresis and "evolution" or "heredity" in physical systems—occurrences where the state of the system is supposed to depend upon the history of the system, *i. e.*, to depend upon the values of certain functions throughout all previous instants of time.

In regard to hysteresis and evolution, in physics as in biology, we may adopt two different points of view. One possible standpoint is that the future state of a system is determined entirely by its state at a given instant, and if the history of a system is used in determining its subsequent behavior, that

[1] As the limit, under proper restrictions, of the ratio of the variation of the function to the integral of the variation of the curve, in that neighborhood.

is merely a sign that the instantaneous conditions are insufficiently known. The other point of view is that the history can not be replaced by the consideration of contemporaneous elements; in other words, that a finite number of present elements can not replace the infinity past instants in the determination of the state of the system. The question as to the presence of heredity effects in physical phenomena is, as Volterra points out, of the same character as the old Newtonian question of action at a distance. In fact, if we take account of the theory of relativity and the four-dimensional space-time space, the two questions meet.

Such questions are important if we try to reduce our system of the world to one that is entirely kinetic. In that case we must get rid of the "coefficients of heredity" by explaining them in terms of concealed motions. It may, however, be impossible completely to reduce physical phenomena to a finite number of elements, no matter how described in terms of functions and variables, without exceeding the time limit for speech; and one method may not be more "fundamental" than another. But regardless of our attitude towards the two aspects of the question, or our opinion of the practical value of making such distinctions on the ground of "reality" or "truth," we can not in any case deny the value of the analysis that enables us to take account of such a thing as the history of the system.

Let us turn now to two subjects, elasticity and electricity, where this analysis seems to be usefully introduced. In the usual treatment of elasticity, we have Hooke's law, connecting the deformations and tensions of the system; in electricity the induction and displacement are also connected by linear relations. If now we assume that the tension at any time depends linearly not only on the deformation at that time, but also on the deformation at all previous times, we can introduce this fact into our equations by adding, in our expression of Hooke's law, a term in the form of an integral, whose integrand represents the contribution to the tension at a time t, due to a deformation acting at a time τ through an interval of time $d\tau$. In this way, Hooke's law becomes an integral equation, or a system of integral equations, and the differential equations that determine the deformations or the tensions become integro-differential equations. In a similar way, integro-differential equations are introduced into the subject of electricity.

The study of the methods of integro-differential equations, their solutions, and their applications to the subject of hysteresis, or heredity, form the subject matter of the book from Chapter V. on. In connection with the relative importance which the theory of this subject has assumed in the presentation of Professor Volterra, we may remember that in the case of elasticity it seems to have received important experimental verification in the work of our American physicists, Professor Webster and Dr. Porter.

A detailed analysis of the contents of the book is unnecessary. Some points, however, should be given special mention, because of their universal interest. Chapter IV. is devoted to functional equations in general; that is, to implicit functions of curves. Theorems are obtained which correspond, first to the inversion of an analytic function, and second to the more extensive theorem on the determination of implicit functions in general. In fact it may be noticed that the theorem might be given in such a form as to include the ordinary theorem on implicit functions as a special case, although with respect to the scope of the book such a generalization would be trivial. The condition for the "closed cycle" (Chapter VII.) deserves special attention, because of its relation to the problem of heredity, which, as we have seen, is a central one for the book. In this chapter, section 10 is a first essay at a possible treatment of magnetic hysteresis. Another interesting subject is the application of permutable functions to the solution of integro-differential equations. It is in connection with this subject that are introduced various new sorts of transcendental functions, similar in a way to the exponential function, the sine, and so on. The quality of periodicity, which appears to be lacking,

might be materialized by means of a slightly different sort of symbolism.

The book does not attempt to give a completely exhaustive account of the subject of functions of curves. It omits notable researches by Hadamard, Levy, Fréchet, and confines itself rather closely to the personal researches of the author, who is of course the inventor of their analysis and the principal source of its development. But if it lacks consideration of some of the possible branches, it makes up for the omission by possessing the artistic quality which is characteristic of unified original work. Moreover, the reader will continually find references to theoretical physics and other branches of mathematics, which, besides illuminating profoundly the matter in hand, testify to a not common comprehensiveness of thought on the part of the author.

G. C. Evans

The Essence of Astronomy. By Edward W. Price. G. P. Putnam's Sons. 1914. Pp. xiv + 207. Illustrated.

The Century Dictionary defines *essence* as being the inward nature, true substance, or constitution of anything. From the title of Mr. Price's book, therefore, one would expect to find something of the inward nature of the solar system, or true substance of the stellar universe, some hint as to the underlying causes and formations of the heavens. But one who opens the book with such expectations will be most grievously disappointed, for the work is but a compilation of the simplest statistical facts; facts which have been compiled and written about over and over again. Further, the book contains some strange and new conceptions: to classify the milky way as a freak, and double and variable stars as oddities, is certainly new, and such classification, itself, might even be called odd and freakish.

The book is well made mechanically, well printed, with clear and beautiful illustrations, but otherwise it is one of dozens of similar crude compilations.

Chas. Lane Poor

An Introduction to General Psychology. By Robert Morris Ogden. Longmans, Green and Co., 1914. Pp. xviii + 270.

Professor Ogden's text-book is the outcome of a definite abandonment of the purely sensationalistic conception of psychology. Dr. Ogden defines his science as "the study of mental happenings." He treats not merely of "mental contents" and their physical conditions, but also of the "mental activities" which constitute what he rather vaguely calls the "purposive aspect" of mental happenings. As elements of mental contents Dr. Ogden enumerates sensations, images, thoughts—which he classifies as notions or relations—and affections. Attention, memory, perception, ideation, emotion and reaction are brought together under the heading "The Synthetic Facts of Mind." The concluding section of the book contains chapters on "mind and body," "personality" and "character." In the last of these chapters Mr. Ogden suggests the relation of psychology to logic, to esthetics, to ethics and to religion. Under the second heading he discusses mainly sleep, dreams, hypnosis, multiple personality and insanity. Not all teachers—it may be noted—will approve the inclusion of the topics just named in a book of fewer than 300 pages; and many will regret the brevity with which all topics are treated and the omission of "all diagrams, references to literature and practical demonstrations."

The writer of this notice is glad to find Professor Ogden in substantial agreement with Herbert Spencer, William James, Binet, Meinong, the Würzburg school, and with several recent American writers in his view that thought-elements as well as sensational and affective elements, should be explicitly acknowledged in a text-book of psychology; and she welcomes also his repeated descriptions of consciousness—the relating consciousness (pp. 14 ff.), affection (pp. 85 ff.) and will (pp. 171 f.)—in terms of the self who is conscious. Occasional artificial constructions and a certain vagueness in the use of the term "mental activity" might indeed have been avoided, had this natural and inevitable point of view been more steadily held.

The book, and in particular chapters I., II., VIII., XII. and XIII., may be commended to those who are interested in the development of psychological theory. Almost every page is marked by the touch of the clear thinker, the first-hand observer, and the careful experimenter.

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PETROLEUM DEVELOPMENTS IN FOREIGN COUNTRIES

THE worldwide activity in the search for petroleum deposits of commercial importance which characterized the year 1913 continued unabated during the early part of 1914. During the later part of the year development in proved areas was greatly curtailed and exploration work postponed on account of the European war and the enormous overproduction of oil in the United States and Mexico.

John D. Northrop, of the United States Geological Survey, is authority for the following statement discussing the petroleum developments in foreign countries in 1914, which has just been made public by the survey.

NORTH AMERICA

Canada.—The productive fields of Ontario and New Brunswick continued to furnish the declining petroleum output of the Dominion. Though considerable effort was made to extend the boundaries of the productive areas, new production sufficient to offset the decline in older wells was obtained only in the Belle River field, Ontario. Good gas wells continue to be found in the Tilbury district, Ontario, but attempts to retard the declining oil output were unsuccessful.

Wildcat activity, with apparently undue interest centered in the vicinity of Calgary, Alberta, was the feature of the year in the western provinces. The discovery of small quantities of high-grade petroleum at depths of 1,562 and 2,700 feet in the Dingman well, southwest of Calgary, created a hysterical rush for mining locations in the area. Drilling was commenced at a number of points southwest and northwest of Calgary and, though proving the presence of small quantities of heavy oil in certain areas of favorable structure, failed to demonstrate the true extent or value of the field before the end of the year. In northern Alberta the lack of transportation facilities retarded the development of the promising oil strikes of the Athabasca Oils, Ltd., near Fort McKay.

In British Columbia encouraging oil indications in the valley of Flathead River and in the vicinity of Revelstoke, Kootenai County, and at Pitt Meadows, New Westminster County, near Vancouver, resulted in more or less prospect drilling.

In Saskatchewan interest was centered at Moose Jaw, where good oil showings were found, but included additional projects at Regina, Battleford, and Saskatoon and in Souris Valley, where oil seepages occur near Roche Percee.

Mexico.—Early in 1914 field operations in the oil districts of Mexico were very active—more so in the northern fields at Panuco and Topila than in the southern fields where the work was interrupted by the belligerent political factions. The bringing in of an enormous gusher by the Corona Oil Co. (Dutch-Shell) at Panuco on January 11 became the signal for a pronounced increase of work in the northern fields, where, as in the southern fields, the lack of adequate storage facilities tended to hamper developments greatly. Work in all districts was abruptly curtailed and in many places terminated by the exodus of operators and workmen beginning in April. Although the subsequent activities of the warring factions resulted in no great damage to the petroleum interests, the resulting conditions of unstable government prevented the resumption of more than nominal activity in the oil fields up to the end of the year. Late in the year the resumption of local oil consumption by the Mexican railroads and mining industries served to revive activity to some extent at Panuco and Topila.

Of more than passing interest was the fire which raged about the famous Potrero del Llano No. 4 well of the Mexican Eagle Oil Co., during the later part of the year. Seepages of

oil escaping to the surface after the well had been capped were ignited by lightning on August 14, and up to the close of the year the fire, though confined to a small area, had defied all efforts to extinguish it.

During the year the Panuco field was extended to the southwest and the Topila field to the west. Wildcatting at Rancho El Chapopote revealed promising indications of an oil field near Campeche, State of Campeche. A four-still topping plant was installed by the Standard Oil Co. at Tampico, and construction work was started by the Tampico & Panuco Valley Tramways Co. on a 25-mile railroad connecting Tampico with the Panuco oil field.

CENTRAL AMERICA AND WEST INDIES

Examination of the petroleum indications in Honduras resulted in the formation of the Honduras Oil Co., financed by Honduras capital, which is reported to have obtained concessions in the departments of Atlantida, Yoro and Comayagua.

By legislative decree the government of San Salvador has granted to Alfredo Leon Schlesinger, a native of Austria-Hungary, the exclusive privilege of conducting geologic studies of the mineral resources of San Salvador for one year and of exploiting them for a period of 30 years, subject to a 25 per cent. royalty and to the reversion of all property to the government at the end of the concession period.

Drilling for oil in Cuba continued in the vicinity of Cardenas.

The testing of promising structure and oil indications in Barbados was retarded by the failure of the legislature to enact laws providing for such exploration.

Developments at Trinidad resulted in a marked increase in production over previous years, despite the deterring effects of meager storage facilities, which, together with the influence of the European war, served to greatly curtail operations toward the end of the year.

SOUTH AMERICA

Colombia.—The discovery of petroleum and natural gas at Tubara, near the important Caribbean seaport of Barranquilla, indicates the development of an important oil field in close proximity to the Panama Canal.

Ecuador.—Investigations of the petroleum indications along the coast and in the mountains near Quito, by a Dutch syndicate, suggest the possible development of Ecuador's petroleum resources in the near future.

Peru.—Developments in the proved oil fields of Peru were without notable incident. The production showed a moderate increase during the early part of the year, necessitating the erection of additional tankage at Zorritos.

Bolivia.—Geologic investigations in the area between the Incahuasi and Aguaraygua ranges have shown the presence of a considerable area of prospective oil land south of Sucre, and the reported acquisition of petroleum concessions in that region indicates that the area will be thoroughly tested.

Chile.—Several companies were organized in Santiago to test certain districts in which surface indications of petroleum have been known for many years.

Argentina.—In the Comodoro Rivadavia oil district, in southern Argentina, 5,000 hectares (12,355 acres) of land has been reserved by the government, of which 350 hectares (865 acres) is being exploited by the state. Legislation providing for the exploitation of the petroleum deposits in Comodoro Rivadavia is now under consideration by the Argentine Congress.

Venezuela.—Work was continued by the Caribbean Petroleum Co., on the east coast of Lake Maracaibo in the shallow-sand field opened late in 1913.

EURASIA

Russia.—On Apsheron Peninsula the oil fields in the vicinity of Baku showed a steady decline, development being retarded by a strike of the oil-field workmen which lasted from June 11 to July 31. In spite of the effects of the strike and the immediately succeeding mobilization of the Russian army, which involved a great number of oil-field workers, the production of the Baku fields made sub-

stantial headway during the later part of the year.

At Grosny, in northeastern Caucasus, extensions of productive area yielded a gratifying increase in production. At Maikop production decreased in spite of significant oil strikes in the Khadijenskaia district, northwest of the developed portion of the field.

In the relatively new Ural-Emba or Ural-Caspian area the Dos Sor field attracted the greatest attention, but minor activity was evident in some forty other fields scattered over an area of 300 square miles east of the mouth of Ural River. A refinery at Bolshaia Rakusha, near Guriev, commenced operations in January. On the east side of the Caspian Sea, in the Ferghana Valley, Turkestan, developments in the new Sel-Rokh field resulted early in the year in a production which surpassed that of the old Tchimion district, Turkestan. Developments in Tcheleken Island were nominal.

Roumania.—Despite the increasingly active drilling campaign which characterized Roumanian developments in the early part of the year and resulted in notable western and southwestern extensions in the Bana-Moreni district and in the discovery of deeper-lying productive strata in the same area, the net production of the country registered a decline. This decline, which was not in any sense due to the exhaustion of the productive fields, resulted in part from interruptions incident to the mobilization of the Roumanian army but chiefly from the conditions of overproduction arising from restricted markets and low prices consequent on the European war, which involved the countries that bound Roumania on all sides. Notwithstanding these retarding influences the later part of the year recorded slight increases of productive areas in the Baicoi-Febatori and Razvadlaid districts.

Austria-Hungary.—In the Galician fields active development early in the year resulted in establishing a southern extension of the Boryslaw field which clearly indicates the ultimate connection of that field with the development at Mraznica. Operations in the oil fields during the later part of the year were much curtailed as the adjacent territory became the theater of conflict between Russian and Austrian troops.

In Hungary the discovery of oil was reported in the village of Morvaor, district of Szenice, Nyitra county.

Spain.—Promising surface indications of petroleum in the area about Cadiz, in southern Spain, were examined at the expense of the Spanish government. In northern Spain, near Santander, petroleum in small quantities was discovered in a boring made for salt.

Turkey.—Plans for the active development of the imperfectly operated oil fields in the Tigris and Euphrates valleys, in the vicinity of Mosul and Bagdad, were postponed by the European war.

In Palestine prospecting was active at Makarim, in the area between the River Jordan and Deraa adjacent to the Hedjaz Railway, by the Turkish Petroleum Co., a successor in interest to the Syrian Exploration Co.

Persia.—Interest in Persian developments was greatly stimulated by the decision of the British government, announced May 22, to acquire a majority interest in the Anglo-Persian Oil Co., and thereby secure for the admiralty undisputed access to valuable oil lands adjacent to the Persian Gulf. The effect of the European war on this agreement was not apparent at the end of the year.

India.—Operations in the Yenangyaung, Singu and Yenangat districts, in Burma, were nominal, the search for deeper sands in the first two districts furnishing variable results not altogether satisfactory. Wildcatting in Burma resulted in the opening of a promising new field at Indaw, Kindat Township, in the upper Chindwin district.

China.—Under the terms of an agreement entered into by the Chinese government and the Standard Oil Co., of New York, a joint investigation of the petroleum resources in and near Autin-fu, Shensi, Chengte and Chihli was undertaken.

Japan.—Interest was centered in the Akita oil district, on the west coast of Nippon, near the north end of the island, where on May 25 and September 1 gushers credited with flows of several thousand barrels daily were brought in by the Nippon Oil Co. In 14 other known oil-

bearing localities in Japan no developments of note were reported.

OCEANIA

In Borneo, Sumatra and Java no notable additions to productive area were made. In the northeastern portion of New Guinea (Papua) petroleum deposits were reported near Eitape, and in the southeastern portion of the island oil indications of great promise were found by Australian geologists on the western flank of the Albert Mountains, between the River Purari on the north and Yule Island on the south.

New Zealand.—Interest was centered in the Taranaki district, New Plymouth, North Island, where late in the year four wells producing oil simultaneously were believed to indicate the presence of a considerable quantity of oil in the locality. On South Island the Shell interests abandoned a test well at 900 feet on account of the presence of metamorphic slate.

AFRICA

Algeria.—Work on the test well of the Algerian oil fields at Abd-er-Rahim was suspended in April, 1914, at a reported depth of 902 meters, on account of parted casing. A second test started in March was located at Messila.

Egypt.—The activity of the Anglo-Egyptian Oilfields, Ltd., resulted in the completion of a number of creditable wells during the year in the Gemsah and Hurgada fields.

Somaliland.—Promising oil indications were found in British Somaliland on the south side of the Gulf of Aden.

A STUDY OF THE INFLUENCE OF VOLCANIC DUST VEILS ON CLIMATIC VARIATIONS

The series of overlapping yearly means of temperature, expressed graphically, show most characteristic crests and depressions. In the case of tropical stations, in particular, the crests of the curves are very regular and recur at intervals of two to three years, practically at the same time all around the world.

As a general result of a detailed study of the temperature data of the years 1900–1909, for Europe, Greenland and North America, I have found some striking correlations between these equatorial variations and the more complicated variations of temperate and arctic regions. This research has been published recently in the *Annals of the New York Academy.*

In another study of all available temperature data of the years 1891–1900, published some years ago, I have shown that terrestrial atmosphere, at the earth's surface, has been warmer in 1900 than in 1893 by at least 0.5° C. On the maps representing the geographical distribution of the departures of annual means from the quasi-normal values of ten-yearly means, the areas of positive departures have been called thermopleions and the areas covered by negative departures antipleions. On the curves of overlapping means the crests correspond to pleions and the depressions correspond to antipleions. I have presumed that the excess of pleions over antipleions, corresponding to pleionian crests of equatorial stations, may be due to an increase of the solar constant.

Recently, many papers have been published about the influence of volcanic dust on meteorological phenomena, on atmospheric temperature in particular, and it has been admitted by different authors that volcanic dust must have been a factor in the production of past climatic changes.

The hypothesis ascribing the origin of climatic variations to the presence of volcanic dust veils in the higher atmospheric layers, is a very plausible argument against my supposition that the changes in terrestrial temperature are due to cosmical causes. Before going any further in my researches on the mode of formation and the dynamics of pleionian variations, it was therefore necessary to find out to what extent one may be justified to suppose that the antipleionian depressions of temperature are simply caused by the presence of volcanic dust veils.

In a paper read before the New York Academy of Sciences on December 7, I have studied

more in detail the effect of the eruptions of 1883, 1902 and 1912 on atmospheric temperature. Only volcanic eruptions of an explosive character had to be taken into special consideration, because it is only when volcanic dust has been projected in great quantity above the ordinary elevation of the cirrus clouds, that this dust could remain in suspension long enough to be spread out all around the globe by the winds of the stratosphere.

In the case of the famous Krakatoa eruption in 1883, the optical phenomena produced by the volcanic dust veil have been observed practically all over the world. The explosion occurred on August 27, 1883. The main sky phenomenon, produced by the dust, went around the world in fifteen days from E. to W. along the equator, spread out N. and S., was observed in the Gulf of Mexico by the end of September and all over the United States in November. Curiously enough, the effect of the Krakatoa dust veil on atmospheric temperature seems to have attracted no special attention.

Besides the Krakatoa, other volcanoes have been very active during the year 1883. St. Augustin and Bogoslof of the Aleutian chain of islands, as well as the Ometepe, may be cited.

The study of the temperature data of the year 1902 is also of special interest, not only because during that year the world's volcanic activity was greatly intensified, but also because some of the explosive eruptions which occurred undoubtedly produced a dust veil in the higher layers of the atmosphere.

Already in 1901 the outbursts of Mt. Colima, Mexico, were more frequent and more intense than during the preceding years. The same in 1902 and even more so in 1903.

On May 7, 1902, La Soufrière, St. Vincent, was in violent eruption. The particular feature of this eruption was the enormous amount of dust which was thrown into the air and distributed over a vast, somewhat elliptical area.

On May 8, 1902, a sea of fire destroyed St. Pierre, Martinique. The following violent eruptions of Mt. Pelée occurred on May 20 and 26, June 6, July 9 and August 30.

The influence these eruptions may have had on the thermal transparency of the higher atmospheric layers is questionable. The excellent photographs taken by Lacroix show, indeed, that the occasional blasts of incandescent gases and ashes did not exceed an altitude of 4,000 m. Only an extremely small proportion of the projected pulverized ashes could have reached the average altitude of the cirrus clouds or even the stratosphere. This may not have been the case in the violent eruptions of the Santa Maria volcano, in Guatemala. The eruptions began on October 24, 1902.

The eruption of the Mua, on Sawaii of the Samoa Islands, which occurred October 30, 1902, was not violent enough to be taken into consideration. The same may be said about the Isalco eruption in Salvador. On the contrary, the Tori-shima eruption of August 7 and 9, 1902, seems to have been very violent.

There can be no doubt that during the year 1902 a considerable quantity of pulverized lava must have been projected into the higher layers of the atmosphere, above the clouds. Bishop's ring was observed anew, as well as extraordinary twilight phenomena, but a comparison is hardly possible with those which were due to the Krakatoa eruption. One single volcanic explosion, if sufficiently violent, may therefore obscure the stratosphere very much more than a score of violent eruptions of a less explosive character.

This seems to have been the case of the Katmai eruption. Katmai volcano is in the Aleutian range, Alaska, latitude 58° N., longitude 155° W., approximately. On the afternoon of June 6, 1912, it suddenly became explosively eruptive, continued in a state of great activity for about three days, and was reported to be still somewhat active at the end of October, 1912.

The fact that the Katmai eruption occurred in a far northern latitude, and has not been followed by similar volcanic outbreaks in other parts of the world, is a most valuable

fact. Because, since the general atmospheric circulation of the southern hemisphere is independent of that of the northern hemisphere, it is difficult to imagine how the haze produced by the Katmai eruption could have been carried south of the equator.

The meteorological observations made on the summit of Pikes Peak extend from 1874 to 1887. It seemed to me that the records of this station—situated near the center of the North American continent, on an altitude of 14,111 feet—may be considered most reliable material for the study of the influence of the dust veil of the years 1883 and 1884 upon temperature conditions in the United States.

In this abstract it is impossible to enter into the details of the discussion. I will therefore simply mention the fact that the curve of the overlapping annual means observed on Pikes Peak compared with other curves, and the Port Darwin curve in particular, forces us to admit that the formation of a pleion in the states has been completely counteracted by the influence of the dust veil. The mean of September, 1883, to August, 1884, must have been affected the most, and this maximum effect of the dust veil must have produced a lowering of the annual mean temperature of about 3.4° F.

The curve of the consecutive means of the temperatures observed at the Batavia Observatory confirms this result, and so do the curves of Singapore, Port Blair, Colombo, Bombay and Aden.

The curves of Bombay and Port Blair, as well as the Port Darwin curve, show distinctly the antipleionian depressions preceding and following the abraded pleionian crest.

During the terrific eruptions of Mt. Pelée, on May 8 and 20, 1902, the usual meteorological observations have been made at Fort-de-France. The mean temperatures were affected but very slightly. The pleionian crest of 1902–03 as indicated on the curve of consecutive means, has been depressed a little, but certainly not more than 0.15° C. or 0.2° F. It is difficult to judge how much the mean temperatures of the individual months have been affected.

The departures of the months of May, 1902, to the end of 1903 are all above the average and if the slight deflections observed during the period of great volcanic eruptions must really be attributed to dust veils, it may be presumed that the means of some months have been affected more than those of other months, but none sufficiently to mask the pleionian character of the departures. Moreover, the effect of the dust veil ceased long before the complete development of the antipleionian depression of 1904–05. This antipleion can, therefore, not be considered as a consequence of the formation of the volcanic dust veil.

The curves of the consecutive means of temperature for Pará, Cayenne and the West Indian stations Port-au-Prince, Sct. Croix Christianssted, St. Lucia and Barbados confirm this result.

A very accentuated depression between 1903 and 1904 is also characteristic for Arequipa and Mauritius, as well as St. Helena. The temperature curve of Apia, Samoa Island, displays the same very pronounced antipleionian depression, completely independent of the formation of the volcanic dust veil of 1902.

Assuming that the volcanic haze produced by the Katmai eruption of June 6, 1912, must have had the greatest effect on the temperatures recorded in Alaska and in Canada, I compared the curves of seven stations in Alaska with the curves of Victoria and Edmonton, Mauritius and Arequipa.

Since Mt. Katmai could not have affected the temperature conditions of Arequipa and Mauritius, it is safe to take the curves of these stations as a standard. Moreover, in my previous publications I have shown that the consecutive means observed at Arequipa express very well the normal pleionian variation and may serve as a standard in all cases of comparison.

The occurrence of the eruption coincided with the pleionian crest of Arequipa. For Arequipa the consecutive mean of July, 1911, to June, 1912, is the highest. From then on the temperature is decreasing till the consecutive mean of October, 1912, to September, 1913. The same at Mauritius.

The curves of the Alaskah stations, the Fort Liscum curve in particular, display practically the same variation as that observed at Arequipa.

The more important conclusions of my research are:

The dust veil produced by the Krakatoa eruption affected atmospheric temperature very greatly. The violent volcanic eruptions of 1902 as well as the Katmai eruption of 1912 influenced the yearly mean temperatures but very slightly or not at all.

The pleionian variations of temperature have nothing in common with the presence or absence of volcanic dust veils.

HENRYK ARCTOWSKI

HASTINGS-ON-HUDSON, N. Y.,
December 8, 1914

SPECIAL ARTICLES

ON THE NATURE OF ANTAGONISM

EXPLANATIONS have been suggested by Loeb and others to account for the antagonistic action of various substances on living protoplasm, but none of them go far enough to enable us to predict what substances (including both electrolytes and non-electrolytes) will antagonize each other and what degree of antagonism will exist between any two substances.

This kind of prediction is apparently made possible by a hypothesis formulated by the writer, as the result of his investigations on the permeability of protoplasm. The testing of this hypothesis has now proceeded far enough to warrant a preliminary statement of its main features.

Substances which alter the permeability of protoplasm may be divided into (1) those which cause an increase, but not a decrease, of permeability and (2) those which can produce a decrease of permeability.[1]

The hypothesis states that substances belonging to the first class will antagonize those belonging to the second, and vice versa. In order to predict which substances will antagonize each other it is only necessary to determine to which of these classes the substances belong. The amount of antagonism may also be predicted, at least to a considerable extent, since the greater effect of the substances on permeability, the greater will be their antagonistic action. This relation may be obscured by secondary causes, so that the predictions which it allows will not be of equal value in all cases.

To illustrate these relations we may take a series of experiments on *Laminaria saccharina* in which the effects of salts on permeability were determined by electrical measurements.[2] In these experiments it was found that NaCl belongs to the first class, being able to increase permeability but not to decrease it, while $CaCl_2$ belongs to the second class, as it is able to decrease permeability.[3] It was found that the antagonism between NaCl and $CaCl_2$ in the case of *Laminaria* is well marked.[4] These facts led the writer to formulate the hypothesis stated above. The next step was to test the hypotheses by the investigation of other salts. Magnesium seemed of special interest for this purpose, as in most of the writer's previous experiments (on other plants) it had shown no antagonism to sodium, though it might be expected on chemical grounds that magnesium and calcium would behave alike. To the surprise of the writer it turned out that magnesium was able to decrease permeability, though its effect was much inferior to that of calcium. The antagonistic relations for *Laminaria* were then investigated, and it was found that $MgCl_2$ was able to antagonize NaCl, though its antagonistic action was much less than that of $CaCl_2$.[5]

This striking and unexpected result strength-

[1] Substances which cause a decrease of permeability may, if the exposure be sufficiently prolonged, cause an increase.

[2] The method is described in SCIENCE, N. S., 35, 112, 1912.

[3] The decrease is followed by an increase if the exposure be sufficiently prolonged.

[4] Pringsheim's *Jahrb. f. wiss. Bot.*, 54, 645, 1914.

[5] The means by which the degree of antagonistic action are measured can not be discussed here. One method has been described in the *Botanical Gazette*, 58, 178 and 122, 1914.

ened the writer's confidence in the hypothesis and led to further investigations. One of these which was of special interest related to acids. For a number of reasons it was supposed that acid would not cause a decrease of permeability. But investigation showed that such a decrease actually occurred in the presence of HCl and it was then a simple matter to predict that antagonism would be found between NaCl and HCl. This turned out to be the case, the amount of antagonism corresponding to the amount of decrease of permeability.[6]

The hypothesis was further tested by investigations on other salts, the most interesting of which are those which (in contrast to those just mentioned) are more effective than $CaCl_2$ in decreasing permeability, such as $La_2(NO_3)_6$, $Ce_2(NO_3)_6$, etc. Here also it was found that the degree of antagonistic action could be foretold by observing the amount of decrease of permeability produced by the pure salts. The results of these investigations afford strong support to the hypothesis.

It seems to the writer that the hypothesis offers a rational explanation of antagonism by showing that salts antagonize each other because they produce *opposite effects on the protoplasm* and by stating definitely what these effects are (it should be noted that they have been measured with considerable accuracy).

The soundness of this point of view is indicated not only by the fact that we are able to predict both qualitatively and (to a considerable extent) quantitatively the effect of combinations of salts[7] but also by the very significant fact that we are able to extend this conception to organic compounds and to show that non-electrolytes which decrease permeability can also antagonize such substances as NaCl. These facts indicate that the hypothesis may be applied in a general manner so as to include both electrolytes and non-electrolytes.

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[6] *The Journal of Biochemistry*, 19, 1914.

[7] It should be noted that mixing solutions of two salts which belong to different classes does not produce an effect which is merely intermediate between the two. For example, tissue may be killed by an exposure of 24 hours in NaCl or in $CaCl_2$ but remain normal in a mixture of these in the proper proportions. *Cf.* Pringsheim's *Jahrb. f. wiss. Bot.*, 54, 645, 1914.

The writer has found cases in which two substances which can decrease permeability are able to antagonize each other. So far as the writer's experiments with *Laminaria* have gone there is no great amount of antagonism in such cases and what there is may perhaps be correlated with the fact that all substances which decrease permeability do not act alike, some producing a much greater decrease than others. Moreover these substances will, if the exposure be sufficiently prolonged, alter their action and increased permeability. The rapidity of this change varies with different substances and this may be related to the fact that some of these substances antagonize each other to some degree. This will be more fully discussed in a subsequent paper.

Experiments on some plants (in which the criterion of antagonism is not electrical resistance but growth) show a fairly strong antagonism between magnesium and calcium. It is possible that for these plants magnesium belongs in the first class.

It will be noted that the hypothesis, as here set forth, says nothing about the mutual relations of substances belonging to the same class but merely states that substances of one class will antagonize those of the other. In this form the hypothesis is completely justified by all the experiments, including those on organic substances.

ISOLATION OF BACILLUS RADICICOLA FROM SOIL

Ever since the epoch-making achievement of Hellriegel and Wilfarth, reported in 1887, which established the symbiotic relationship between bacteria and legumes in the fixation of atmospheric nitrogen, the legume bacteria, named in 1901, *Bacillus radicicola* by Beijerinck, have been the object of numerous investigations in all parts of the world. These investigations have assumed a variety of forms and were planned from both the economic and pure science points of view. There has ever remained, nevertheless, the unsolved problem of the direct isolation of *Bacillus radicicola* from the soil. Sporadic attempts, rather few in number, have been made to attain that end, but,

to quote Russell,[1] "none of these organisms (*B. radicicola*), however, could be found in the soil, nor indeed has any one yet succeeded in finding them there, although their existence can not be doubted." In the literature available to us we have found but one instance in which a claim is made of the direct isolation of *B. radicicola* from soil not artificially inoculated. That one is the investigation of Gage[2] who has himself rendered questionable the value of his work by an unfortunately confused use of terminology which has only served to make more difficult than otherwise a comprehension of the present status of the subject. Kellerman and Leonard[3] in studying Greig-Smith's claim to having discovered a specific medium for *B. radicicola* could not find experimental evidence to confirm it. Incidentally the last-named investigators tried to obtain *B. radicicola* from different soils some of which grew legumes but were unsuccessful in the attempt except in the case of one soil into which pure cultures of *B. radicicola* had been introduced after its isolation from alfalfa nodules.

While not deeming the matter one of great moment in any sense, since there can be no doubt, as Russell remarks, that *B. radicicola* is present in any soil in which nodules are found on legumes, the writers decided to attempt the isolation of that organism, and, as a matter of record, submit this brief paper in evidence of the success of their attempt. One of us had for three or four years used as a source of *B. radicicola* for student work in the laboratory the nodules of a large specimen of *Vicia sicula* growing in the Botanic Gardens on the campus of the University of California, and we therefore decided to attempt the isolation of *B. radicicola* from the soil in which that plant had grown. The plant had been removed a year or more prior to our initiation of the experiment and the soil had remained bare and unused during that time. Seeds from the plant in question were scattered all over the surface of the ground, and we gathered them for the later tests which are described below. The soil, so far as we can ascertain, had never been artificially inoculated with cultures of *B. radicicola*.

Some of the soil just described was taken from below the surface at a depth of about six to eight inches, placed in a sterile container and removed to the laboratory. About 30 grams of the soil were there placed in a sterile bottle, 150 c.c. of sterile water added, and the whole shaken, after being stoppered, for fifteen minutes. The necessary dilutions were then made for purposes of pouring plates. The agar employed at first was of two kinds. The first was similar to that employed by Fred and was constituted as follows:

1,000 grams water
10 grams maltose
1 gram K_2HPO_4 (separately neutralized)
1 gram $MgSO_4$
2 or 3 drops each of 10 per cent. solutions of NaCl, $FeCl_3$, $MnSO_4$ and $CaCl_2$
15 grams agar-agar.

The second was a soil extract agar prepared by dissolving 15 grams of agar and 10 grams of maltose in an aqueous extract from the soil above described. The aqueous extract was obtained by boiling one part of soil with three parts of water for one hour and filtering.

In the preliminary tests the soil extract agar gave by far the better results with both the soil to be studied and with commercial cultures of *B. radicicola* which were employed as controls. By better results we mean that a larger number of colonies developed on the plates poured with the soil extract agar than on those prepared with Fred's *radicicola* agar. In the later work therefore the soil extract agar was employed exclusively.

From plates of the proper dilution prepared as above described transfers were made to soil extract maltose agar slants by means of a platinum needle from all colonies which appeared to be characteristic of *B. radicicola* and in fact of any others which appeared to be different from one another. Transfers were thus made from forty-four colonies. After three or four days of growth on the slants, slides were pre-

[1] "Soil Conditions and Plant Growth," D. Van Nostrand Co., 1912, p. 95.

[2] *Cent. für Bakt.*, 2te Abt., Vol. 27, p. 7.

[3] SCIENCE, N. S., Vol. 38, p. 95.

pared from all of these organisms and microscopic examinations after several transfers and platings showed the forty-four cultures to be pure. The form of the organisms as viewed under the high power of the microscope varied from short to long rods to oval forms. The detailed results of these examinations, however, can not be given in this brief paper.

The next step in the investigation was to test the powers of inoculation of the forty-four organisms obtained as above described. Our procedure was as follows: A large quantity of fertile sandy soil from Anaheim, Cal., was sterilized in the autoclave for four hours at about 1½ atmospheres of pressure. When it had cooled it was distributed in quantities making a thickness of three inches in quart-size glass fruit jars. The latter were then securely stoppered with cotton and sterilized in the autoclave, thus giving the soil a double sterilization. The jars were then put away for three days to allow the soil to become normally aerated again, and several samples were carefully withdrawn for testing as to sterility. No colonies developed on the agar plates even after many days. The soil thus being shown to be sterile, we proceeded with the *Vicia* seeds as follows. The seeds were placed in a 1 to 1,000 $HgCl_2$ solution and kept there for ten minutes. They were then thoroughly rinsed with distilled water and treated with concentrated H_2SO_4 for 20 minutes to aid germination. They were then again thoroughly rinsed in sterile distilled water and removed to a sterilized moist chamber containing several layers of water-saturated filter paper. The seeds which thus gave perfect germination in 3 or 4 days as against very poor germination for similar seed untreated with H_2SO_4 were then transferred to the jars with sterile forceps and pressed into the soil by means of a sterilized glass rod without removing the stoppers from the jars. It may be added here that every jar received fifty c.c. of a .5 per cent. dextrose solution to furnish optimum moisture conditions and a proper source of energy for *B. radicicola*. Five seeds were planted in every jar and the inoculation was accomplished by the addition, in every case, of a 5 c.c. suspension of the agar slant culture with sterile distilled water. The jars were removed to the greenhouse and remained there for fifty-four days, sterile distilled water being carefully added when necessary. All the plants in all the jars appeared to grow equally well and attained a height of about eight inches. Evidently there was an ample supply of nitrogen in the ammonia or closely related forms to supply even the plants in the five control jars which received no inoculation. Besides the control jars and the forty-four others above described, there were five jars inoculated with commercial cultures as follows: (1) Farmogerm, (2) Nitrogen-gathering Bacteria, (3) Ferguson's Nitrogen Fixing Bacteria, (4) Mulford's Nitro-Germ (weak culture), (5) Mulford's Nitro-Germ (strong culture). After the period mentioned the plants were carefully removed from the soil in every jar and the roots examined, with the following results.

1. No nodules were found on the roots of any of the plants in the control jars.

2. Twenty-one of the forty-four inoculations with bacteria isolated from the soil above described gave positive results and nodules were found on the roots of some or all of the plants in those jars.

3. The balance or twenty-three inoculations gave negative results and none of the plants in those jars showed the presence of nodules on the roots.

4. All the commercial culture inoculations produced nodules except the weak culture obtained from one of the Mulford transfers.

These results would seem therefore to record the first isolation, so far as we know, of *B. radicicola* directly from the soil; to show that that organism so obtained at least in some forms and places can be readily made to grow on agar plates in large numbers; and to make desirable the use of soil extract-maltose agar for such purposes.

The writers will welcome criticisms of their work which may occur to their colleagues, and to be corrected if, in error, as to priority (excepting Gage's investigation) so far as the recorded isolation of *B. radicicola* is con-

cerned. Many other facts of interest besides those above discussed have come to light in our investigation, but the limited space of this paper will not permit of their discussion, nor of the submission here of the detailed data which furnish the basis for the discussion above given.

C. B. LIPMAN,
L. W. FOWLER

THE AMERICAN PHYSICAL SOCIETY

THE seventy-fifth meeting of the Physical Society was held in Randall-Morgan Laboratory of the University of Pennsylvania, December 29, 1914, to January 1, 1915. It was a joint meeting with Section B of the American Association for the Advancement of Science. Morning and afternoon sessions were held on Tuesday, Wednesday and Thursday. Vice-president Anthony Zeleny, of Section B, presided on Tuesday and Wednesday afternoons, and President Merritt at the other four sessions.

On Tuesday afternoon the program consisted of the Vice-presidential Address before Section B on "Recent Evidence for the Existence of the Nucleus Atom," by A. D. Cole, and the presidential address of the American Physical Society on "Luminescence," by Ernest Merritt. On Wednesday afternoon there was a symposium on the Use of Dimensional Equations, led by E. Buckingham, who was followed by A. C. Lunn, A. G. Webster, W. S. Franklin and others.

The following program of papers was presented:

"An A. C. Bridge for the Measurement of the Dielectric Loss and Dielectric Constant at High Voltages and Low Frequencies," by Chester A. Butman.

"Influence of the Concentration of Electrolyte upon Electrode Potentials," by Arthur W. Ewell.

"A New Method of Obtaining a Hysteresis Loop," by W. N. Fenninger.

"On Rotation and Magnetization," by S. J. Barnett.

"Note on Thermo E.M.F.'s in which the Resultant Peltier Effect is Zero," by H. C. Barker.

"Linear Resistance Change with Temperature of Certain Molten Metals," by E. F. Northrup.

"The Effect of Temperature on the Dielectric Strength, the Dielectric Loss and the Dielectric Constant of Paraffine Oil," by Chester A. Butman.

"A Preliminary Note on the Variation of Stray Power Losses in a Dynamo," by W. N. Fenninger.

"Relation Between the Energy of the Cathode Rays and the Frequency of the X-Rays Produced by Them," by William Duane.

"Thermionic Currents from a Wehnelt Cathode," by W. Wilson.

"Mobility of Ions at Different Temperature and Constant Gas Density," by Henry A. Erikson.

"The Radioactive Content of Certain Minnesota Soils," by James C. Sanderson. (Read by H. A. Erikson.)

"Conducting Gas Layer at a Metallic Surface," by G. W. Stewart.

"X-Rays From the Electrical Discharge," by Elizabeth R. Laird.

"X-Rays Produced by Slow-moving Cathode Rays," by Elizabeth R. Laird.

"Light Due to Recombination of Ions," by C. D. Child.

"Electric Furnace Evidence on the Relation of Spectrum Lines Having Constant Differences in Wave-Number" (by title), by Arthur S. King.

"The Mechanical Equivalent of Light," by H. E. Ives, W. W. Coblentz and E. F. Kingsbury.

"Fluorescence of the Uranyl Salts under X-Ray Excitation," by Frances G. Wick.

"The Efficiency of Energy Transformation in the Corona Method of Precipitating Fumes," by W. W. Strong.

"Leakage of Gas Through Quartz Tubes" (by title), by E. C. Mayer.

"A New Method for Measuring Gravity at Sea, with Some Trans-Pacific Observations," by Lyman J. Briggs.

"The Oxidation of Nitrogen," by W. W. Strong.

"The Alleged Dissymmetrical Broadening of the D Lines of Sodium," by E. A. Eckhardt.

"Exhibit of Mechanical Models Illustrating (*a*) Subdivision of Alternating Current Between Two Branches in Parallel, (*b*) The Alternating Current Transformer, (*c*) Coupled Circuits in Wireless Telegraphy," by W. S. Franklin.

"Some Causes of Variation in the Sensitivity of Moving Coil Galvanometers," by Paul E. Klopsteg. (Presented by A. Zeleny.)

"A New Standard Phone and Phonometer for any Pitch," by A. G. Webster.

"A New Form of Radiation Pyrometer" (by title), by S. Leroy Brown.

"The Doppler Effect in X-Ray Spectra and Application to the Kinetic Theory of Solids," by L. Gilchrist and D. A. Keys.

"On Acoustic Impedence, and an Approximate Theory of Conical Horns," by A. G. Webster.

"Vapors with Positive Specific Heat in Energy Conversion" (by title), by J. E. Siebel.

"Progress of B-Particles through Matter," by A. F. Kovarik and L. W. McKeehan.

"A Thirty-two Element Harmonic Synthesizer," by Dayton C. Miller.

"The Result of Plotting the Separation of Homologous Pairs against Atomic Numbers instead of Atomic Weights," by Herbert E. Ives and Otto Stuhlmann.

"Beaded Lightning," by W. J. Humphreys.

"A Practical Measurement of Colors," by H. E. Wetherill.

"Preliminary Note on a Mercury-vapor Tube

Oscillator,'' by B. Liebowitz. (Introduced by M. I. Pupin.)

On Tuesday evening a public lecture, complimentary to the citizens of Philadelphia and illustrated by experiments and the lantern, was given by Dayton C. Miller. On Wednesday evening a successful dinner for physicists was arranged by Professor H. C. Richards at the Hotel Normandie. This was enjoyed by about seventy members. The members of the society were the guests of the University of Pennsylvania at lunch each day of the meeting. The registration of the meeting was 117. The attendance at the various sessions was exceptionally uniform and varied between 100 and 150.

A. D. Cole,
Secretary

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The one-hundredth regular meeting of the Botanical Society of Washington was held in the Crystal dining room of the new Ebbitt Hotel, at 6 P.M., December 1, 1914. One hundred and four members and eight guests were present. A dinner was served at which were featured several dishes made from plants which have been introduced to this country by the U. S. Department of Agriculture. Drs. W. Ralph Jones, J. S. Cooley, H. V. Harlan and Messrs. G. F. Gravatt, G. H. Godfrey, L. M. Hutchins, Paul Popenoe and R. G. Pierce were unanimously elected to membership. The remainder of the evening was given to a special program dealing with the early history and growth of the society with the following papers:

Mr. M. B. Waite, ''The Botanical Seminar and the Early Development of Plant Pathology in Washington.''

The Botanical Seminar was founded in 1893. The purpose of the members was to make the meetings as informal as possible. The monthly meetings were held at the rooms of the various members. There were no officers other than the speaker of the evening, who usually was the person entertaining the Seminar. There was no constitution or by-laws. Refreshments were served and very frank discussion and criticism was encouraged. In 1901 the number of candidates for membership became so great that this method of holding meetings became impossible and the Botanical Seminar was merged with the Washington Botanical Club to form the present Botanical Society of Washington. The speaker sketched briefly the development of the work in plant pathology in Washington from the early beginning when the pathological work was a very small branch of the botanist's duties, up to the present large body of investigators.

Letters from the Boys in Washington: Mr. David Fairchild.

This consisted in the reading of actual letters from various early workers in plant pathology and physiology and brought home to those present the actual condition of things at that time more vividly than could have been done in any other way.

The Washington Botanical Club: Dr. Edward L. Greene.

The Washington Botanical Club was founded in 1898 with a very informal organization quite similar to that of the Botanical Seminar. The Botanical Club included more especially the workers in systematic botany. Dr. Greene was the first and only president. In 1901 it was merged with the Botanical Seminar to form the Botanical Society of Washington.

Systematic Botany: Mr. F. V. Coville.

Mr. Coville gave briefly some of the more important features of systematic botany in Washington from the early days up to the present time, emphasizing the use of types of species which was a direct contribution of the United States Department of Agriculture.

Early History of Physiological and Plant Breeding Work in the Department of Agriculture: Mr. Walter T. Swingle.

This briefly sketched the beginning of the now extensive work in plant pathology and plant breeding in the U. S. Department of Agriculture.

On Tuesday, January 5, 1915, at 8:30 P.M., the Botanical Society of Washington met in joint session with the Washington Academy of Sciences in the Assembly Hall of the Cosmos Club. Professor J. C. Bose gave an illustrated lecture on ''The Response of Plants.''

The one-hundred-and-first regular meeting of the Botanical Society of Washington was held January 9, 1915, at 1:30 P.M., in the west wing of the new Department of Agriculture building. Thirty-four members were present. Messrs. F. Tracy Hubbard, Howard S. Coe, Luther P. Byars and Dr. L. O. Kunkel were unanimously elected to membership. The resignation of Mr. H. C. Gore, as treasurer of the society, was accepted and Mr. C. E. Leighty was elected to that office. No scientific program was presented.

Perley Spaulding,
Corresponding Secretary